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SIXTH ANNUAL REPORT
OF THE
METROPOLITAN SEWERAGE COMMISSION

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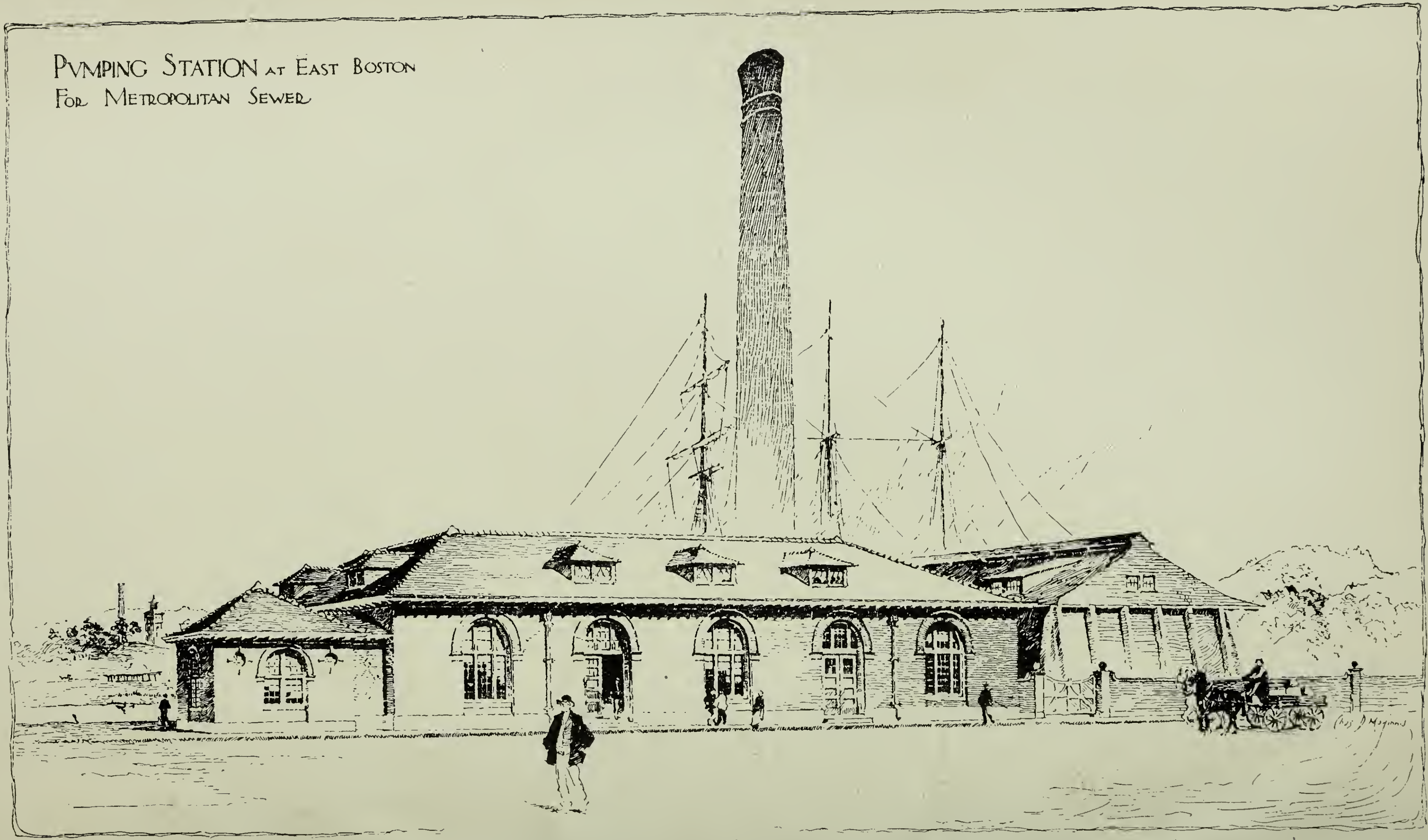

SKETCH FROM ADDISON STREET. MAIN BUILDING AND CHIMNEY COMPLETED.

Proposed screen house.

Proposed coal pocket.

PUBLIC DOCUMENT . . . . No. 45.

SIXTH ANNUAL REPORT

OF THE

BOARD

OF

METROPOLITAN SEWERAGE COMMISSIONERS,

FOR THE

YEAR ENDING SEPTEMBER 30, 1894.

BOSTON:
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Commonwealth of Massachusetts.

To the Honorable the Senate and the House of Representatives.

The Board of Metropolitan Sewerage Commissioners, created by chapter 439, Acts of 1889, presents its annual report, which is the sixth since its organization, and covers the year ending Sept. 30, 1894.

Continued and steady progress has been made upon the work entrusted to this Board, the past year. The main line of the north metropolitan system from its extreme northern point in Stoneham has been completed to the outlet at Deer Island, excepting small gaps at Malden River, Belle Isle Inlet, the extreme end of the outlet itself, and the pumping stations, all of which are now in process of construction. Work on branches is progressing on Eastern Avenue, Chelsea, in East Boston, Charlestown and Somerville, along the line of the Mystic River. The branch extending through Everett, Malden and Melrose to Stoneham, and also that in Winchester and Woburn, designed to relieve Cummingsville, are practically complete. The two branches extending into Somerville and Cambridge, the one following the general line of Alewife Brook and the other extending through the eastern portion of said cities, lack the completion of the siphons under Mystic River and the construction of the pumping stations to render them available, upon the completion of the main line.

In accordance with the suggestions of the committee of the Legislature of 1894, a very large proportion of the work this year has been done by day labor; and, while it has possibly been of a more thorough and substantial character than contract work, this, together with the prosecution by the State of several important contracts, where the contractors had met extraordinary difficulties and had failed to overcome them, has entailed a largely increased cost for construction.

The Charles River system has been in operation during the year, and numerous connections have been made therewith by the towns and cities thereon. A list of these, and also a table showing the cost of operating this system, are submitted herewith. Your attention is respectfully invited to the report of our chief engineer and the tables that follow in connection with this report.

NORTH METROPOLITAN SYSTEM.

The following tables show the condition of the work upon this system at this date (Oct. 1, 1894), and your attention is called to the map accompanying our engineer's report for comparison therewith: —

NORTH METROPOLITAN SYSTEM (COMPLETED SECTIONS), SEPT. 30, 1894.

Main Line.

SECTION.	Location.	Length of Sections (Feet).	Completed.
Wharf,	Deer Island,	400	Feb. 3, 1891.
2,	Deer Island,	2,430	Dec. 19, 1891.
3,	Deer Island,	2,641	Aug. 8, 1891.
3½,	Shirley Gut,	430	Sept. 30, 1894.
4,	Winthrop,	5,710	June 27, 1891.
5,	Winthrop,	4,600	Dec. 2, 1891.
6,	Winthrop,	4,113	Sept. 30, 1891.
8,	East Boston,	4,126	June 23, 1892.
9,	East Boston,	3,382	June 24, 1892.
	East Boston pumping station and connections,	210	– –
10,	Between East Boston and Chelsea,	709	May 23, 1894.
12,	Chelsea,	3,034	March 4, 1893.
14,	Chelsea,	3,445	Aug. 19, 1893.
15,	Chelsea,	1,754	July 20, 1892.
16,	Everett,	4,431	May 20, 1893.
17,	Everett,	3,527	Feb. 6, 1893.
17½,	Everett,	1,627	Aug. 10, 1892.
20,	Medford,	9,185	Aug. 5, 1893.
21,	Medford,	8,270	Sept. 10, 1892.
22,	Medford,	6,033	Dec. 23, 1893.
44,	Winchester,	5,608	Jan. 20, 1894.
44½,	Winchester,	5,684	Jan. 20, 1894.
45,	Winchester,	6,508	Oct. 21, 1893.
46,	Winchester and Woburn,	5,756	Dec. 2, 1893.

NORTH METROPOLITAN SYSTEM (COMPLETED SECTIONS) — *Concluded.*

East Boston Branch.

SECTION.	Location.	Length of Sections (Feet).	Completed.
36,	East Boston,	237	Sept. 25, 1894.
37½,	East Boston,	276	Aug. 3, 1894.

Cambridge Branch.

23,	Everett,	2,268	April 29, 1893.
24,	Everett and Charlestown,	2,332	June 2, 1892.
25,	Mystic River,	2,125	April 9, 1894.
25½,	Charlestown,		April 9, 1894.
26,	Charlestown and Somerville,	9,026	May 27, 1893.
27,	Somerville and Cambridge,		Dec. 23, 1893.
28,	Cambridge,	6,503	Feb. 17, 1894.
29,	Cambridge,	5,157	March 17, 1894.
30,	Cambridge,	7,033	Dec. 12, 1893.

Malden and Melrose Branch.

40,	Everett and Malden,	6,252	April 15, 1893.
41,	Malden and Melrose,	10,807	Dec. 9, 1893.
42,	Melrose and Stoneham,	3,050	June 3, 1893.

Alewife Brook Branch.

43,	Cambridge and Somerville,	14,450	Dec. 30, 1893.
43½,	Medford and Somerville (contract),	2,327	Sept. 30, 1893.
	Total,	165,456	
	Less 400 feet of wharf,	400	
		165,056	

NORTH METROPOLITAN SYSTEM (UNCOMPLETED SECTIONS), SEPT. 30, 1894.

Main Line.

SECTION.	Location.	Approximate Length of Sections (Feet).	Completed Sept. 30, 1894 (Feet).	To be Constructed (Feet).
1, .	Deer Island, ...	1,925	1,506	419
7, .	Winthrop and East Boston, .	848	776	72
19, .	Malden River, ...	496	304	192
47, .	Winchester and Woburn, .	4,510	4,277	233

East Boston Branch.

SECTION.	Location.	Approximate Length of Sections (Feet).	Completed Sept. 30, 1894 (Feet).	To be Constructed (Feet).
37, .	East Boston, ...	4,882	4,795	87
38, .	East Boston, ...	8,229	1,870	6,359
39, .	East Boston, ...	6,963	2,535	4,428

Chelsea Branch.

SECTION.	Location.	Approximate Length of Sections (Feet).	Completed Sept. 30, 1894 (Feet).	To be Constructed (Feet).
11, .	Chelsea, ...	3,030	2,000	1,030

Charlestown Branch.

SECTION.	Location.	Approximate Length of Sections (Feet).	Completed Sept. 30, 1894 (Feet).	To be Constructed (Feet).
31, .	Charlestown, ...	4,500	1,650	2,850
32, .	Charlestown, ...	6,277	3,468	2,809
35, .	Charlestown, Somerville and Medford, ...	8,370	3,180	5,190

Alewife Brook Branch.

SECTION.	Location.	Approximate Length of Sections (Feet).	Completed Sept. 30, 1894 (Feet).	To be Constructed (Feet).
43½, .	Medford and Somerville (including pumping station and siphon), ...	270	–*	270
		50,300	26,361	23,939

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* Begun Sept. 17, 1894.

The total length of the sewer upon the north metropolitan system and its branches (including pumping stations and siphons) is 215,756 feet (about 41 miles). Of this the completed portion amounts to 191,817 feet (36⅓ miles), while the portion remaining to be constructed amounts to 23,939 feet (about 4⅔ miles). This is entirely independent of and separate from the Charles River valley system, covering a distance of about 8¼ miles, which has been completed and in operation since the spring of 1892.

The following settlements for land taken upon this system have been made during the year: —

James Hewins and others, as assignees of the estate of Moody Merrill of Boston, quit-claimed to the Commonwealth a tract of land in Chelsea, which had been taken by this Board by deed dated Oct. 8, 1892, and recorded in Suffolk Registry of Deeds, book 2088, page 541. Their release is recorded in Suffolk Registry of Deeds, book 2165, page 504, and the land so conveyed forms a part of the site of the sand-catcher and siphon at Chelsea Creek.

On Oct. 18, 1893, Catherine E. W. Clark, executrix and trustee of David Oakes Clark, together with other heirs, quit-claimed to the Commonwealth by deed (recorded Middlesex South District Registry, book 2234, page 386) land in Everett taken by this Board by its deed dated Oct. 28, 1891, and recorded in Middlesex South District Deeds, book 2076, page 262.

Lynde Sullivan also releases to the Commonwealth, by deed dated Oct. 12, 1893 (recorded Middlesex South District Deeds, book 2229, page 222), "rights, privileges and easements" in land in Everett, comprised within the taking made by this Board, Aug. 17, 1891 (recorded Middlesex South District Deeds, book 2064, page 142); and Charles W. Howland, by deed dated Nov. 1, 1893 (recorded Middlesex South District Deeds, book 2234, page 385), releases the Commonwealth "from all suits, claims and demands for damages, costs, expenses or compensation by reason of the aforesaid taking, . . . and especially for all claims for injury to wells and loss of water supply and for interruption in business." By deed dated Nov. 8, 1893 (recorded Middlesex South District Deeds, book 2235, page 598), William

Thompson, Mary W. Thompson and George P. Thompson, the latter individually and as executor under the will of Emily P. Eayrs, deceased, quit-claimed to the Commonwealth the "rights, privileges and easements" in a parcel of land in Everett included in the aforesaid taking.

A deed from Annie Urquhart, dated Nov. 14, 1893 (recorded Middlesex South District Deeds, book 2235, page 599), quit-claims to the Commonwealth "rights, privileges and easements" in land in Everett included in a taking dated April 23, 1892 (recorded Middlesex South District Deeds, book 2111, page 203); and Stephen C. Currier, by deed dated Nov. 24, 1893 (recorded Middlesex South District Deeds, book 2242, page 8), gives a similar release to land in Everett included within the same taking.

A deed from James W. Tufts, dated Nov. 28, 1893 (recorded Middlesex South District Deeds, book 2242, page 11), releases the Commonwealth for damages to land included within a taking made Nov. 25, 1891, and recorded with Middlesex South District Deeds, book 2083, page 368.

A deed dated Dec. 5, 1893, from Moses P. Richardson, in his own right and as the executor of Samuel Richardson, deceased, with Roswell C. Richardson and others, quit-claims to the Commonwealth the "rights, privileges and easements" to a certain tract of land in Winchester, taken by this Board Aug. 19, 1893, and recorded with Middlesex South District Deeds, book 2218, page 117. The deed from Richardson is recorded in Middlesex South District Deeds, book 2251, page 301; and in part compensation therefor, by authority of chapter 251, Acts of 1892, this Board, on Feb. 3, 1894, conveyed to said parties a strip of land taken by said Board April 22, 1893 (recorded Middlesex South District Deeds, book 2189, page 249), no longer needed for the construction of the sewer.

James O. Goodwin of Medford, by deed dated Dec. 23, 1893 (recorded Middlesex South District Deeds, book 2253, page 17), quit-claims "rights, privileges and easements" in certain land in West Medford included in a taking by this Board dated Dec. 23, 1891, and recorded in Middlesex South District Deeds, book 2089, page 361.

On Jan. 22, 1894, Edward Brooks and other trustees, under the will of Francis Brooks, late of Medford, and others, release and discharge the Commonwealth from all "suits, actions, claims and demands by us for damages, costs, expenses or compensation," by reason of a taking made Dec. 23, 1891, and recorded with Middlesex South District Deeds, book 2089, page 361, "or connected with or growing out of the construction of the sewer in said premises."

On Jan. 23, 1894, Leonard B. Usher of Lynn quit-claimed to the Commonwealth "rights, privileges and easements" in and to a certain parcel of land in Medford, included in the taking of this Board dated Dec. 23, 1891, and recorded with Middlesex South District Deeds, book 2089, page 361. This deed is recorded in Middlesex South District Deeds, book 2250, page 558; and in part consideration this Board, by authority of the aforementioned act of 1892, quit-claimed to said Usher all the land included within the said taking outside of a strip four feet wide on each side of the centre line of said taking.

On Jan. 24, 1894, Sylvanus C. Small of Winchester, trustee for the Suburban Land Improvement Company, quit-claimed to the Commonwealth "rights, privileges and easements" to two parcels of land in Winchester, included within a taking made by this Board April 22, 1893, and recorded in Middlesex South District Deeds, book 2189, page 249. This deed is recorded with Middlesex South District Deeds, book 2253, page 15, and is accompanied by a release from the Third National Bank of Boston, the holder of a certain mortgage given by said Small to Freeman A. Loring, dated Sept. 10, 1891. The said release is recorded in Middlesex South District Deeds, book 2253, page 16. The aforesaid deeds are further secured by a statement bearing date of Jan. 24, 1894, from James W. Brooks and Frank F. Stanley, trustees of the McKay Metallic Fastening Association, the mortgagees named in a certain mortgage deed given by Sylvanus C. Small, dated April 27, 1893, acknowledging that said mortgage was not delivered until April 29, 1893, and waiving all claim to receive damages by reason of the taking made by the Metropolitan Sewerage Commissioners of certain easements in a portion of the premises described in said mortgage.

By deed dated Feb. 9, 1894, Maria E. Mills of Winchester quit-claims to the Commonwealth "rights, privileges and easements" in two parcels of land in Winchester, included in takings made by this Board, the one dated April 22, 1893 (recorded Middlesex South District Deeds, book 2189, page 249), the other dated Aug. 19, 1893, and recorded in the aforesaid Registry, book 2218, page 117. The deed from Mills is recorded in Middlesex South District Deeds, book 2263, page 569, and is accompanied by a quit-claim of even date from Martha J. Richardson of Winchester, mortgagee, of the rights, privileges and easements described in the aforesaid deed. This release is recorded in Middlesex South District Deeds, book 2263, page 570.

A deed dated March 2, 1894 (recorded Middlesex South District Deeds, book 2263, page 568), from Bardwell A. Goodell and James H. Winn, quit-claims to the Commonwealth the "rights, privileges and easements" in and to certain land in Winchester, included within a taking made by this Board April 22, 1893, and recorded with Middlesex South District Deeds, book 2189, page 249.

Benjamin Hadley of Somerville, on April 4, 1894, by deed (recorded in Middlesex South District Deeds, book 2268, page 266) quit-claims to the Commonwealth land in Everett, included within the taking made by this Board, Aug. 17, 1891, and recorded with Middlesex South District Deeds, book 2064, page 142; and by deed of even date Benjamin Hadley and Wilbur P. Rice quit-claim to the Commonwealth five several parcels of land in Everett, included in the aforesaid taking. This deed is recorded with Middlesex South District Deeds, book 2268, page 261, and is accompanied by a deed dated Jan. 11, 1894, from George W. Bartlett and others to the said Rice and Hadley, of all their right and claim against the Commonwealth for damages and compensation for the taking of this Board, dated Aug. 17, 1891. This deed of Bartlett and others to Rice and Hadley is recorded in Middlesex South District Deeds, book 2268, page 264.

A deed dated April 12, 1894, and recorded with Middlesex South District Deeds, book 2273, page 475, from Benjamin F. Webb, William M. Scott and others, constituting the firm of Baeder, Adamson & Co., quit-claims to the Commonwealth "rights, privileges and easements" in a certain parcel of land in Woburn, taken by this Board April 15, 1893, by a taking recorded with Middlesex South District Deeds, book 2186, page 585. Accompanying this deed is a deed from the Philadelphia Trust, Safe Deposit and Insurance Company, executor and trustee of the will of Charles Baeder, deceased, the mortgagee named in a certain mortgage, dated Dec. 14, 1889, releasing unto the Commonwealth the "rights, privileges and easements" described in the foregoing deed from Webb and others. This release is recorded with Middlesex South District Deeds, book 2273, page 477.

By a deed bearing date of April 12, 1894, and recorded with Middlesex South District Deeds, book 2269, page 451, John M. Brown and others, heirs of Ellen R. Brown, quit-claimed to the Commonwealth "rights, privileges and easements" in land in Cambridge, included within a taking made by this commission July 19, 1893 (recorded in Middlesex South District Deeds, book 2210, page 481); and by deed of even date John M. Brown releases and quit-claims to the Commonwealth "rights, privileges and easements" in land in Cambridge included within the aforesaid taking. The latter deed is recorded in Middlesex South District Deeds, book 2269, page 449.

By deed dated May 4, 1894 (recorded in Middlesex South District Deeds, book 2274, page 208), Bridget M. Nelson releases to the Commonwealth land in Winchester included in a taking made by this Board, dated April 22, 1893, recorded with Middlesex South District Deeds, book 2189, page 249; and by deed of even date (recorded in Middlesex South District Deeds, book 2274, page 207), Michael S. Nelson quit-claims to the Commonwealth certain land in Winchester, included within the said taking. This last deed is accompanied by releases from Samuel S. Porter of Winchester, the mortgagee named in a mortgage given by Michael S. Nelson, dated July 1, 1887, and also by one from Margaret Nelson of Winchester, the mortgagee named in a mortgage given by said Nelson, dated Feb. 3, 1890, releasing in both instances the "rights, privileges and easements" described in the deed from Nelson to the Commonwealth. The release of Porter to the Commonwealth is recorded with Middlesex South District Deeds, book 2274, page 211; that from Margaret Nelson to the Commonwealth with the aforesaid District Deeds, book 2274, page 210.

A deed bearing date of May 15, 1894 (recorded with Middlesex South District Deeds, book 2278, page 207), from Edward Kendall, and Willard A. Bullard, trustee under the will of Caleb Wood, late of Cambridge, releases and discharges the Commonwealth, its officers, agents and servants from all suits, actions, claims and demands for damages, costs, expenses or compensation, by reason of the taking made by this Board March 25, 1893, in said Cambridge (recorded with Middlesex South District Deeds, book 2183, page 245); and Robert O. Fuller, by deed dated May 21, 1894 (recorded with Middlesex South District Deeds, book 2293, page 214), quit-claims to the Commonwealth "rights, privileges and easements" in land in Cambridge included within the aforesaid taking of March 25, 1893.

A deed dated May 31, 1894, and recorded with Middlesex South District Deeds, book 2283, page 279, from Joseph D. Decelle, trustee under the will of Caroline Brodeur, late of Winchester, Herbert J. Decelle, the beneficiary named in said will, and Helen A. Pressey, the assignee of a certain mortgage given by said Brodeur *et al.* to Josiah F. Stone, trustee, dated March 14, 1878, releases and discharges the Commonwealth, its officers, agents and servants from damages, costs, expenses or compensation, by reason of the taking made by this board July 14, 1893, and recorded with Middlesex South District Deeds, book 2210, page 162.

By a deed dated June 16, 1894 (recorded with Middlesex South District Deeds, book 2293, page 211), the Boston Rubber Shoe Company, by its treasurer, Elisha S. Converse, duly authorized thereto, quit-claims and releases to the Commonwealth the "rights, privileges and easements" in and to certain parcels of land in Melrose included in the taking made by this Board July 23, 1892, and recorded with Middlesex South District Deeds, book 2133, page 550.

Francis McBreirty, by his deed dated July 11, 1894, releases and discharges the Commonwealth, its officers, agents and servants from all suits, actions, claims and demands for damages, costs, expenses or compensation, by reason of the taking made by this Board, dated Oct. 3, 1891 (recorded with Middlesex South District Deeds, book 2071, page 162), and the construction of the sewer in the said premises.

Bridget McDonald of Woburn, by a deed dated July 17, 1894 (recorded with Middlesex South District Deeds, book 2300, page 465), quit-claims to the Commonwealth "rights, privileges and easements" in land in said Woburn, included in a taking by this Board, dated April 15, 1893, and recorded in Middlesex South District Deeds, book 2186, page 585.

The North Packing and Provision Company, by Gustavus F. Swift, its president, duly authorized thereto, in a deed dated July 17, 1894 (recorded with Middlesex South District Deeds, book 2293, page 213), quit-claims to the Commonwealth "rights, privileges and easements" in its land in Somerville, taken by this Board June 11, 1892, in a taking recorded with Middlesex South District Deeds, book 2124, page 126.

Alexis Cutting of Winchester, by two deeds dated Sept. 11, 1894, releases and discharges the Commonwealth, its officers, agents and servants, from all suits, actions, claims and demands for damages by reason of two takings made by this Board in behalf of the Commonwealth. The one dated May 20, 1893 (recorded with Middlesex South District Deeds, book 2197, page 139), includes a tract of land in Medford on the North side of the Mystic River at the end of Canal Street. This release is recorded in Middlesex South District Deeds, book 2311, page 550, and Edward Eayrs joins the aforesaid grantor in the release. The other release includes land in Winchester comprised within the taking dated July 14, 1893, and recorded in Middlesex South District Deeds, book 2210, page 162. This release is recorded with Middlesex South District Deeds, book 2311, pages 549 and 550, and George G. Crocker and Henry H. Sprague join the grantor in said release.

George A. Wellington of Medford, by a deed dated Sept. 13, 1894 (recorded with Middlesex South District Deeds, book 2312, page 109), quit-claims to the Commonwealth "rights, privileges and easements" in land in that part of Medford called Wellington, included within a taking made by this Board Oct. 3, 1891, and recorded with Middlesex South District Deeds, book 2071, page 162. This is accompanied by an assignment from Fred C. Patch of Wakefield, dated July 17, 1894, "to the aforesaid Wellington of all right, title and interest in and to any damages due me by reason of the aforesaid taking."

A release from Alfred A. Baldwin, dated Sept. 18, 1894, discharges the Commonwealth, its officers, agents and servants, from all suits, actions, claims and demands for damages by reason of the taking made by this Board Oct. 28, 1891, and recorded with Middlesex South District Deeds, book 2076, page 262. This release covers a narrow strip of land in Everett in the neighborhood of the Malden River.

A release of Patrick Fedigan of Stoneham, dated Sept. 20, 1894 (recorded with Middlesex South District Deeds, book 2311, page 551), discharges the Commonwealth, its officers, agents and servants, of all suits, actions, claims and demands for damages, by reason of the taking signed by this Board April 15, 1893, and recorded with Middlesex South District Deeds, book 2186, page 585. This covers a tract of land in Woburn on the main line of the sewer.

A similar release from Michael Casey of Malden, dated Sept. 21, 1894 (recorded with Middlesex South District Deeds, book 2311, page 548), covers a tract of land on the line of the Malden and Melrose branch, included within the taking of this Board dated Oct. 3, 1891, and recorded with Middlesex South District Deeds, book 2071, page 162.

On Sept. 22, 1894, Francis T. Baker of New York, Frederick Eayrs of Taunton and other heirs of Joseph H. Eayrs, late of Boston, by deed recorded with Middlesex South District Deeds, book 2311, page 543, release and quit-claim to the Commonwealth "rights, privileges and easements" in a certain parcel of land in Everett included within the taking made by this Board Aug. 17, 1891, and recorded with Middlesex South District Deeds, book 2064, page 142. "Rights, privileges and easements" in a tract of land in Everett included within the aforesaid taking, dated Aug. 17, 1891, were quit-claimed to the Commonwealth by Lewis P. True of Everett, by deed dated Sept. 22, 1894 (recorded with Middlesex South District Deeds, book 2311, page 552);

and Adeline True, wife of said Lewis, by deed of even date quit-claims to the Commonwealth similar rights in certain land in Everett included in the taking of this Board, dated Oct. 28, 1891, and recorded with Middlesex South District Deeds, book 2076, page 262. The latter deed is recorded in Middlesex South District Deeds, book 2311, page 551.

Damages to the several pieces of land in Medford belonging to George S. Hatch and others, included within the taking made Nov. 25, 1891, and recorded with Middlesex South District Deeds, book 2083, page 368, were paid by the Commonwealth upon an execution issued from the superior court; and similar damages sustained by James M. Usher, administrator, to land in Medford included in the taking made by this Board Dec. 23, 1891, and recorded in Middlesex South District Deeds, book 2089, page 361, were likewise settled by the Commonwealth.

Land Takings.

On the map accompanying our engineer's report of last year the portions shown in yellow lines indicated the sections then remaining to be constructed, and for which no right of way had been taken. These comprise Section 11, on Eastern Avenue, Chelsea; sections 38 and 39, in East Boston; sections 31 and 32, Charlestown; Section 35, partly in Charlestown and partly in Somerville and Medford; and Section 47, in Winchester and Woburn. The right of way on Section 11 was taken by this Board by deed executed May 26, 1894 (recorded with Suffolk Deeds, book 2203, page 425), and includes that portion of Eastern Avenue, Chelsea, between Marginal and Willoughby streets. Sections 38 and 39, East Boston, were taken by this Board by deed executed June 2, 1894 (recorded with Suffolk Deeds, book 2203, page 602), and comprise portions of the public streets of that section. A deed executed by this Board June 2, 1894 (recorded in Suffolk Deeds, book 2203, page 426), takes that portion of Section 35 lying in Charlestown, and also that portion of Section 31 lying in Main, Cambridge and Chapman streets, and Rutherford Avenue. Another taking, executed by this Board June 9, 1894 (recorded in Suffolk Deeds, book 2205, page 340), starts on Chapman

Street, at a point about thirty-five feet west of Rutherford Avenue, and extends to Front Street in the neighborhood of the Boston & Maine freight station on said street, and from thence follows Front and Water streets to the gate of the Navy Yard, opposite the latter street. Another taking on this same section was made by this Board Sept. 29, 1894 (recorded in Suffolk Registry, book 2227, page 42), and comprised that portion of Chelsea Street opposite the Navy Yard in Charlestown, included between the south-westerly line of Vine Street and the north-easterly line of Medford Street. A deed dated June 9, 1894 (recorded with Middlesex South District Deeds, book 2282, page 195), includes that portion of Section 35 lying in Somerville and Medford; and on June 2, 1894, this Board, by deed (recorded in Middlesex South District Deeds, book 2282, page 388), took "rights, privileges and easements" in land lying in Winchester and Woburn on the line of Section 47.

Location of Sewer Line.

A glance at the map will show that the takings made this year are entirely upon branches in Chelsea, East Boston, Charlestown, Somerville, Medford, Winchester and Woburn. On Section 11 the line of the sewer starts at a point near the junction of Marginal Street with Eastern Avenue in Chelsea, and follows the line of this avenue, a public street, to its junction with Willoughby Street. Sections 38 and 39 lie wholly in the public streets of East Boston. Beginning at the junction of Bremen and Marion streets, the terminus of Section 37, Section 38 continues through Bremen Street and an extension of Decatur Street to Orleans Street, which street it follows to Marginal Street; thence it follows the line of Marginal Street to a point about 1,600 feet from said Orleans Street. A branch extends from Orleans Street through Maverick Street to Jeffries Street, and through the latter street to the southerly line of Sumner Street. Section 39 starts on Porter Street at its junction with Bremen Street, and passes through Porter Street to Central Square. It continues through said square, passing around the park to Border Street, and then follows Border Street northerly as far as Condor Street and southerly to Maverick Street. At

Maverick Street it passes through said street and New Street to the southerly line of Summer Street, the terminus at this end of the line. On the north the line passes from Border to Condor Street to its junction with Meridian Street, where it terminates. Section 31 begins in Charlestown in Sullivan Square, where it joins Section 26, the branch which passes through Charlestown, Somerville and Cambridge. From this point one branch follows Main Street to its junction with Beach Street; another follows Rutherford Avenue to Chapman Street, and continues on Chapman Street about thirty-five feet, where the section terminates. Section 32 begins at the point last named on Chapman Street, and passes by tunnel under sundry private estates and public streets to the location of the Boston & Maine freight shed on Front Street. Here it passes through said street to Water Street, and follows the line of the latter to the gate of the Navy Yard, and after passing through said yard it comes out on Chelsea Street, opposite Vine Street, and continues on Chelsea Street to Medford Street. Section 35 begins at a point in the tract of land on Alford Street, Charlestown, acquired by the city of Boston for a public park, opposite Arlington Avenue, and included within the taking made by this Board June 24, 1893, and continues across said land and Alford Street to Arlington Avenue, which avenue it follows to land of the Boston & Maine Railroad Company. Crossing this land, it meets Mystic Avenue in Somerville near its junction with Austin Street, and follows this avenue through Somerville and Medford to about fifty feet beyond the boundary line between said cities. Section 47 is the branch designed for the relief of Cummingsville and its vicinity. It leaves the main line of the sewer at the junction of Lake and Main streets, in Winchester, and follows the former street and Linden Street to private land of Isaac H. Kendall. From here to the boundary line between Woburn and Winchester, and some thirty feet beyond said line in Woburn, it passes through private estates, following in general the line of Horn Pond Brook.

The right of way through the Charlestown Navy Yard has not yet been formally taken by this Board. The following correspondence, however, passed between this Board and the department at Washington in relation to the same: —

Board of Metropolitan Sewerage Commissioners of Massachusetts,
Boston, Sept. 23, 1893.

To the Hon. Hilary A. Herbert,
Secretary of the Navy of the United States of America.

Respectfully represents the Board of Metropolitan Sewerage Commissioners of Massachusetts, created under and in pursuance of an act of the General Court of said Commonwealth, entitled "An act to provide for the building, maintenance and operation of a system of sewage disposal for the Mystic and Charles River valleys," approved June 7, A.D. 1889, and being chapter 439 of the Acts of said year; that the route selected for the metropolitan sewer lies through the United States Navy Yard, Charlestown, Mass. The route selected has been approved by the civil engineer at that place. This proposed metropolitan sewer would intercept the sewage of city sewers which now discharge into the Navy Yard dock. Mr. Howard A. Carson, our chief engineer, is at your service to furnish any further information you may desire.

Wherefore this Board respectfully requests that this work in the position indicated on the enclosed tracing No. 1765 ("Proposed location of the metropolitan sewer in the United States Navy Yard, Charlestown, Mass.," signed by Hosea Kingman, chairman, and Howard A. Carson, chief engineer) may be authorized, approved and permitted.

(Signed) Hosea Kingman,
Chairman Metropolitan Sewerage Commissioners.

The following communication was received in reply: —

Navy Department,
Washington, Oct. 24, 1893.

Sir: — The department has considered the matters presented in your communication of the 23d ultimo, in which, as chairman of the Metropolitan Sewerage Commission, created in pursuance of an act of the General Court of the Commonwealth of Massachusetts, entitled "An act to provide for the building, maintenance and operation of a system of sewage disposal for the Mystic and Charles River valleys," you state that the route selected for the metropolitan sewer lies through the Navy Yard, Charlestown, Mass., and request that this work, in the position indicated on the tracing (tracing No. 1765) which accompanies your letter, may be authorized.

It appears from an examination of the tracing referred to that the proposed sewer will intercept the sewage of the city sewers which now discharge into the Navy Yard dock.

The chief of the Bureau of the Yards and Docks, in response to an inquiry made by the department upon the receipt of your communication above mentioned, makes the following report: —

> The original line, as laid down in red ink in the accompanying plan for the sewer in question, is approved and recommended by the Bureau, provided that the ropewalk and wall shall not be in any wise disturbed, but shall be tunnelled; that appropriate branches shall be built to connect with the yard sewers; that all dirt left over, after filling up excavations, shall be removed from the yard by and at the expense of the State Commissioners; that the suface shall be left as at present and clear of all débris; that the State Commissioners shall repair or pay for any damage to the government property; and that the work shall be completed in a reasonable time, — that is to say, that from its commencement to completion in the yard the work shall not be abandoned or retarded temporarily, except on account of bad weather.

It is the desire of this department to grant all proper facilities, within the limits of its authority, in aid of the construction of a work of this character. It is to be borne in mind, however, that the department has no power, without the sanction of Congress, to grant any irrevocable privilege or right, or to authorize the construction of a permanent work of any kind, in or upon the Navy Yard lands, the disposal of which rests exclusively with Congress; nor can the department properly undertake to bear any of the expenses incident to or consequent upon the construction or maintenance in repair of such work, in the absence of an appropriation available for these purposes.

It is apparent, from the above statement, that any permission, authorization or license which the department might grant in this case must be subject to revocation at any time when such action is required by the public interests, or is rendered necessary in order to carry out the provisions of any act of Congress.

If, notwithstanding the limitations upon the department's power in a matter of this character, the Board still desires the approval of the location selected for the intercepting sewer in question, such location will be approved, and the necessary orders issued to permit the construction of the work under the restrictions above mentioned.

Very respectfully,

(Signed) H. A. HERBERT,

Secretary of the Navy.

MR. HOSEA KINGMAN, *Chairman Metropolitan Sewerage Commission,*
110 Boylston Street, Boston, Mass.

The following letter was then sent: —

Board of Metropolitan Sewerage Commissioners of Massachusetts,
Boston, Oct. 28, 1893.

Hon. H. A. Herbert,
Secretary of the Navy, Washington, D. C.

Dear Sir: — Your communication of Oct. 24, 1893, received and duly considered by this Board. We do still desire the approval of the location selected for the metropolitan sewer, and request that the necessary orders be issued to permit the construction of the work under the restrictions named in your said communication.

For the Board,
Yours very respectfully,
(Signed) Hosea Kingman, *Chairman.*

In reply to which the following letters were received: —

Navy Department,
Office of the Judge Advocate General,
Washington, Oct. 31, 1893.

Gentlemen: — Referring to the department's communication of the 24th instant, and to your reply to the same, dated the 28th idem, I transmit herewith for your information a copy of the department's action in the matter of the construction of an intercepting sewer through the Navy Yard, Charlestown, Mass., under the restrictions stated in the department's communication above referred to.

By direction of the Secretary of the Navy,
Very respectfully,
(Signed) James C. Lewis,
Judge Advocate General

Metropolitan Sewerage Commissioners,
110 Boylston Street, Boston, Mass.

Navy Department,
Washington, Oct. 31, 1893

Subject: Metropolitan Sewerage Commission, Boston, Mass., requests permission to construct intersecting sewer through the Navy Yard, Boston, Mass.

Returned to the Bureau of Yards and Docks.

In a communication dated Oct. 24, 1893, the department advised the Metropolitan Sewerage Commission of the contents of the Bureau's indorsement of the 19th instant, and informed the commission that, while it was its desire to grant all proper facilities within the limits of its authority in aid of the construction of a work of this character, the department has no power, without the sanction of Congress, to grant any irrevocable privilege or right, or to authorize the construction of a permanent work of any kind, in or upon Navy Yard lands, the disposal of which rests exclusively with Congress. The commission were further advised that the department cannot properly undertake in the present case to bear any of the expenses incident to, or consequent upon, the construction or maintenance in repair of such a work, but were informed that if, notwithstanding the limitations and restrictions mentioned, the Board still desired the approval of the location selected for the intersecting sewer in question, such location would be approved, and the necessary orders issued to permit the construction of the work under the restrictions mentioned.

The Metropolitan Sewerage Commission, having signified, in a communication dated the 28th instant, that after due consideration they still desire the approval of the location selected for the metropolitan sewer, and having requested that the necessary orders be issued to permit the construction of the work, under the restrictions named in the department's communication of October 24, the recommendation contained in the Bureau's indorsement of the 19th instant herewith, that the original line, as laid down in red ink in the accompanying plan for the sewer in question, be adopted, is approved, and the Bureau is hereby authorized to issue the orders and instructions necessary to permit the Metropolitan Sewerage Commission to construct the intercepting sewer in question, under the restrictions named in the Bureau's indorsement, it being further expressly understood that the permission or license hereby granted is subject to revocation at any time when such action may be required by the public interests or rendered necessary in order to carry out the provisions of any act of Congress.

A copy of the department's letter of the 24th instant, and the communication of the Metropolitan Sewerage Commission assenting to the conditions therein set forth, are enclosed for the Bureau's information.

(Signed) H. A. Herbert,
Secretary of the Navy.

The following letter was also received from the Commodore Commandant of the Navy Yard, accompanied by a copy of the foregoing letter from the Secretary of the Navy, dated Oct. 31, 1893: —

U. S. Navy Yard,
Boston, Nov. 14, 1893.

Sir: — In compliance with instructions from the Bureau of Yards and Docks, I enclose herewith for your information a copy of the department's indorsement upon a communication to that Bureau, and would respectfully inform you that I have issued the necessary instructions to permit the Metropolitan Sewerage Commission to construct the intercepting sewer in question, under the restrictions named.

I would thank you to inform me about the time it is proposed to commence the work.

Very respectfully,
(Signed) JOSEPH FYFFE,
Commodore Commandant.

MR. HOSEA KINGMAN, *Chairman Metropolitan Sewerage Commission,*
110 Boylston Street, Boston, Mass.

To this the following reply was sent: —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS OF MASSACHUSETTS,
BOSTON, NOV. 18, 1893.

Commodore JOSEPH FYFFE,
Commandant U. S. Navy Yard, Boston, Mass.

SIR: — Your letter of the 14th inst., with a copy of the indorsement from the Department of Yards and Docks, came duly to hand and was laid before the Board this day. The work contemplated will probably not be entered upon until some time late in the winter or early in the spring, but timely notice will be given you thereof.

For the Board,
Yours very respectfully,
(Signed) EDWARD P. FISK,
Clerk.

The following correspondence passed between this Board and the War Department at Washington in regard to crossing sections of the tidal waters in Boston harbor by the sewer: —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS OF MASSACHUSETTS,
BOSTON, Jan. 20, 1894.

To the Hon. DANIEL S. LAMONT,
Secretary of War of the United States of America.

Respectfully represents the Board of Metropolitan Sewerage Commissioners, ordered by chapter 439 of the Acts of 1889 of the General Court of said Commonwealth to construct the metropolitan sewerage system; that your department approved, April 9, 1891, various constructions in Boston harbor pertaining to this system, and among others a siphon under Malden River, which siphon was shown on Tracing No. 833 (submitted March 21, 1891). The said tracing showed the siphon to consist of two lines of thirty-six-inch pipe. The Board now desires to change the cross-section according to the method of construction used, to slightly change the location of the southerly pipe (the upper surfaces of the pipes to remain as before), and to somewhat alter the pipe chambers; all as shown on drawing and tracing numbered 1856 submitted herewith.

Mr. Howard A. Carson, our chief engineer, is at your service to furnish any further information you may desire.

Wherefore this Board respectfully requests that the said changed construction, as above described, may be authorized, approved and permitted.

(Signed) Hosea Kingman,
Chairman Metropolitan Sewerage Commissioners.

The reply of the War Department follows, together with a copy of an instrument attached to and expressing the approval of the said department of the aforementioned plan numbered 1856.

War Department,
Washington, D. C., Feb. 16, 1894.

Sir: — Referring to your letter of Jan. 20, 1894, herewith please find for retention an instrument expressing the approval of this department, under section 3 of the river and harbor act, approved July 13, 1892, of the amended plans of a siphon under Malden River, in Boston harbor, Mass., to be constructed by the Board of Metropolitan Sewerage Commissioners of Boston, Mass.

Very respectfully,
(Signed) Joseph P. Doe,
Acting Secretary of War.

Hosea Kingman, Esq.,
Chairman Metropolitan Sewerage Commissioners, Boston, Mass.

Whereas, By section 3 of an act of Congress, approved July 13, 1892, entitled "An act making appropriations for the construction, repair and preservation of certain public works on rivers and harbors, and for other purposes," it is provided that, without the permission of the Secretary of War, it shall not be lawful to build any wharf, pier, dolphin, boom, dam, weir, breakwater, bulkhead, jetty or structures of any kind outside established harbor lines, or where no harbor lines are or may be established, in any port, roadstead, haven, harbor, navigable river or other waters of the United States, in such manner as shall obstruct or impair navigation, commerce or anchorage of said waters; or to excavate or fill, or in any manner to alter or modify the course, location, condition or capacity of any port, roadstead, haven, harbor, harbor of refuge or inclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless approved and authorized by the Secretary of War;

And Whereas, The Board of Metropolitan Sewerage Commissioners, ordered by chapter 439 of the Acts of 1889 of the General Court of the Commonwealth of Massachusetts to construct the metropolitan sewerage system, has submitted to the Secretary of War for his approval amended plans of a siphon under Malden River, in Boston harbor, Mass., and has applied for permission to construct said siphon in accordance with said plans;

Now, Therefore, This is to certify that the Acting Secretary of War hereby gives permission to the said Board of Metropolitan Sewerage Commissioners to construct said siphon in accordance with said plans, which are hereto attached, and hereby approves and authorizes the excavation and filling which may be necessary in constructing said siphon, subject, however, to the following condition: —

That all the work to be done under this instrument shall be subject to the supervision and approval of the engineer officer of the United States Army in charge of the locality.

Witness my hand this sixteenth day of February, 1894.

(Signed) Joseph B. Doe,
Acting Secretary of War.

[Seal of the War Office.]

On Feb. 3, 1894, this plan was submitted to the Board of Harbor and Land Commissioners, and received their approval on the 26th of the same month. On Sept. 20, 1894, this Board again submitted to the Harbor and Land Commissioners plans for a siphon under Mystic River between Medford and Somerville, near Boston Avenue bridge, and this plan received their approval Sept. 28, 1894.

Contracts.

Contracts for eight new sections, all of them branches, have been made on this line during the past year. The methods of advertising, receiving bids and awarding contracts, described in our previous reports, were followed in these particular cases. On May 5 bids were received for the construction of sections 35, 38, 39 and 47, particulars of which are contained in Table A of the Appendix. These sections were awarded in each case to the lowest bidders; James Heath & Son of Lynn receiving the contracts on sections 35 and 38, the Metropolitan Construction Company of Boston that on Section 39, and Lindsey & Cudmore of Somerville that on Section 47. On May 12 bids were received for three other sections, particulars of which will be found in Table A of the Appendix. The lowest bidders in each case were awarded the contracts, Charles Linehan receiving that on Section 11 and the Metropolitan Construction Company those on sections 31 and 32. On August 25 this Board awarded the contract on Section 36, a short branch of Section 37 in East Boston, extending across Eagle Square, to the National Construction Company, the only bidder upon this section. On Dec. 2, 1893, the chief engineer submitted to the Board three bids for the construction of the siphon at Abbajona River, he having previously been authorized by the Board to communicate with contractors regarding the same. The lowest of the three, that of Thomas J. Young & Co., was accepted, and the contract therefor duly executed. On May 19, 1894, the following certificate was presented to the Board by the chief engineer: —

Boston, May 19, 1894.

Hosea Kingman, Tilly Haynes, Harvey N. Collison,
Metropolitan Sewerage Commissioners.

Gentlemen: — I hereby certify that in my opinion the work on the sand-catcher, siphon and sewer across Abbajona River, Winchester, Thomas J. Young & Co., contractors, is unnecessarily and unreasonably delayed.

Yours respectfully,
(Signed) H. A. Carson,
Chief Engineer.

Thereupon the Board —

Voted, That Thomas J. Young & Co., contractors for work on a sand-catcher, siphon and sewer across Abbajona River, Winchester, be notified to discontinue all work under their contract dated Dec. 2, 1893, for work on said section; that work on said section be immediately prosecuted by the Board, under the direction of the engineer, in accordance with the provisions of Section L of the specifications for Section 44½.

The contractors were duly notified, the work was taken from them and prosecuted by the Board under the direction of the engineer, and duly completed at an advance over their bid of some fifteen hundred dollars.

On Feb. 17, 1894, the chief engineer presented a report, showing that the work contracted for by McGovern & Kitch upon Section 27, Cambridge and Somerville, and taken from them by vote of the Board Oct. 15, 1892, had been completed at an expense of $17,489.20 in excess of the contract price. The following communication was thereupon sent to the contractors: —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS OF MASSACHUSETTS,
BOSTON, March 1, 1894.

Messrs. McGOVERN & KITCH,
15 E. Walnut Street, Lancaster, Penn.

GENTLEMEN: — Under the provisions of Section L of the contract, executed by you May 7, 1892, with the Commonwealth, by its Board of Metropolitan Sewerage Commissioners, for the construction of Section 27, north metropolitan system, this Board has completed said section at a cost of $17,489.20 in excess of contract price (as per enclosed statement), after crediting the balance which you would have been entitled to had you performed your contract; and now demand of you payment to the Commonwealth of the sum of $6,000, the amount of the bond given by you for the completion of the work.

For the Board,
Yours truly,
(Signed) EDWARD P. FISK,
Clerk.

The American Surety Company of New York, the surety on the bond given the Commonwealth by the said contractors, was also notified; and the Board received the following from the contractors: —

BOSTON, MASS., March 5, 1894.

GENTLEMEN: — We have received the letter of your clerk demanding payment of bond under contract of May 7, 1892. We have placed the bond in the hands of Mr. Freedom Hutchinson of 23 Court Street, Boston, to make such settlement of the matter as his judgment may approve.

Yours respectfully,
(Signed) McGOVERN & KITCH.

To the Sewer Commissioners of Metropolitan System, Mass.

On March 17 the attorney of the Board, William D. Turner, was directed to bring suit on the bond of McGovern & Kitch. Suit was brought and is now pending in the superior court.

On July 14 the chief engineer called the attention of the Board to the delay in the work upon Section 7, Belle Isle Inlet, by the contractors, Trumbull & Ryan. They were notified to meet the Board for consultation regarding the completion of said section on the following Saturday, July 21, when, after hearing these contractors, the following communication was submitted by the chief engineer: —

HOSEA KINGMAN, TILLY HAYNES, HARVEY N. COLLISON,
Metropolitan Sewerage Commissioners.

GENTLEMEN: — I hereby certify that in my opinion the work on Section 7, Belle Isle Inlet, is unnecessarily and unreasonably delayed, and I earnestly recommend that the work be taken at once from the contractors and prosecuted directly by the Board.

Yours respectfully,
(Signed) H. A. CARSON,
Chief Engineer.

The Board thereupon passed the following vote: —

Voted, That Trumbull & Ryan, the contractors for work on Section 7, be notified to discontinue all work under their contract for work on said section; that work on said section be immediately prosecuted by the Board, under the direction of the engineer, in accordance with the provisions of Section L of their contract.

The contractors and their bondsmen were duly notified thereof, and work on this section has since been prosecuted by this Board, under the direction of the engineer. On September 12 the following communication was submitted to the Board by the chief engineer: —

BOSTON, Sept. 8, 1894.

HOSEA KINGMAN, TILLY HAYNES, HARVEY N. COLLISON,
Metropolitan Sewerage Commissioners.

GENTLEMEN: — As I have heretofore stated to you in person, the work on Section 39, and especially that on Porter Street, between Bremen Street and Central Square, East Boston, is in my opinion unnecessarily and unreasonably delayed.

Yours respectfully,
(Signed) H. A. CARSON,
Chief Engineer.

The Board thereupon passed the following vote: —

Voted, That the Metropolitan Construction Company, the contractors for work on Section 39, East Boston, be notified to discontinue all work under their contract on that portion of said section lying on Porter Street between Bremen Street and Central Square; that work on said portion of the section be immediately prosecuted by the Board, under the direction of the engineer, in accordance with the provisions of Section L of their contract.

In accordance with the foregoing vote, work has also been prosecuted here by the Board, under the direction of its chief engineer.

Contracts for Pumping Stations.

Contracts have been made the past year for the erection of pumping stations at Mystic River (Charlestown), Chelsea Creek (East Boston) and Deer Island, contracts for the erection of the pumping plants having been executed in 1893. On March 31, 1894, seventeen bids were received for the construction of the pumping station on Deer Island, from which after due consideration the Board accepted that of Gooch & Pray of Boston, the lowest bidders. (Table B, Appendix, contains a full list of bids on this and the other pumping stations.) The bids for the East Boston station, fourteen in number, were received and opened April 14, 1894, Edward E. Strout of Lynn, the lowest bidder, receiving the award. The bids for the station at Charlestown were received and opened Aug. 11, 1894. From sixteen bids then submitted, that of Edward Lynch & Co., the lowest, was accepted.

Claims of Contractors.

The claims of several of the contractors upon this line for additional compensation under their contracts and for extra work have been settled, among them the following: —

R. A. Malone & Son, by a release dated Dec. 2, 1893, discharge the Commonwealth "of all claims and demands arising out of our contracts relating to said sections" (sections 23, 16 and 40). On June 7, 1894, Andrew W. Bryne gives a similar release to the Commonwealth for his claims growing out of the construction of Section 22. On the 25th of the same month Orrin P. Roberts releases the Commonwealth from all additional claims growing out of the construction of Section 12; and the Metropolitan Construction Company, by a release dated July 12, 1894, releases the Commonwealth from all claims whatsoever growing out of the construction of Section 14, excepting, however, the reserve held by this Board under the provisions of its contract on said section. Besides the foregoing, there have been several minor claims of small amounts settled.

The towns and cities embraced within this system have been authorized to connect their local sewers with the metropolitan sewer, in accordance with plans approved by this Board, as shown in the following table. Some of them have already made connections and others are in progress, while others still are yet to be commenced.

CONNECTIONS WITH NORTH METROPOLITAN SEWER, AUTHORIZED TO OCT. 1, 1894.

DATE AUTHORIZED.	City or Town.	Location of Connection.	Size.	Date of Connection.
Nov. 4, 1893, . .	Malden, . .	Corner Charles and Middlesex streets, ...	25 by 38 inches,	Jan. 9, 1894.
Jan. 27, 1894, . .	Winthrop, . .	Shirley Street, corner Washington Avenue, ...	12 inch, . .	Not yet connected.
March 24, 1894, . .	Everett, . .	Under tracks of Boston & Maine Railroad, near East Everett station, . . .	24 inch, . .	July 3, 1894.
May 5, 1894, . .	Malden, . .	Extension of Pearl Street, near dividing line of Malden and Medford, . . .	24 inch, . .	May 20, 1894.
May 26, 1894, . .	Medford, . .	Riverside Avenue, near to and east of Gravelly Creek, ...	18 inch, . .	June 13, 1894.
May 26, 1894, . .	Medford, . .	South side metropolitan sewer, in Medford Square, ...	12 inch, . .	June 13, 1894.
May 26, 1894, . .	Medford, . .	North side metropolitan sewer, in Riverside Avenue, junction of Spring Street, .	18 inch, . .	Not yet connected.
May 26, 1894, . .	Medford, . .	South side metropolitan sewer, Riverside Avenue, junction of Park and Marine avenues.	12 inch, . .	Not yet connected.
July 21, 1894, . .	Melrose, . .	Corner Wyoming Avenue and Pleasant Street, ...	20 inch, . .	Not yet connected.
Aug. 25, 1894, . .	Malden, . .	Mountain Avenue, ...	15 inch, . .	Not yet connected.
Aug. 25, 1894, . .	Medford, . .	West side metropolitan sewer, in private land on west end of Canal Street and Boston Avenue.	12 inch, . .	Sept. 12, 1894.
Aug. 25, 1894, . .	Medford, . .	North side metropolitan sewer, in Prospect Street, corner Cottage Street, . .	12 inch, . .	Sept. 14, 1894.
Aug. 25, 1894, . .	Medford, . .	North side metropolitan sewer, in private land, about four hundred and sixty feet west of Winthrop Street and south of High Street.	12 inch, . .	Not yet connected.

MAINTAINING AND OPERATING THE NORTH METROPOLITAN SYSTEM.

The following communication was sent to the treasurer of the Commonwealth by this Board on Jan. 26, 1894 : —

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS OF MASSACHUSETTS,
BOSTON, Jan. 26, 1894.

To the Treasurer of the Commonwealth of Massachusetts,
State House, Boston, Mass.

SIR : — On Sept. 27, 1890, we transmitted to you a certificate of our estimate (then made) of the cost of the maintenance and operation of the system of sewage disposal for the cities of Boston, Cambridge, Somerville, Malden, Chelsea and Woburn, and the towns of Stoneham, Melrose, Winchester, Arlington, Belmont, Medford, Everett and Winthrop (called by us the north metropolitan system), for each of the years of 1890 to 1895 inclusive.

By that estimate the sum of $74,000 was given as the cost for the year 1894, and the sum of $89,000 as the cost for the year 1895.

We now estimate and certify that for the year 1894 the sum of $43,000 will be sufficient to pay such cost, and the cost for the year 1895 will be $89,000.

(Signed) HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Metropolitan Sewerage Commissioners.

This was duly referred to the Legislature then in session, and the amount for 1894 ($43,000) was appropriated by chapter 131, Acts of 1894. As this system is not yet in operation, the amount so appropriated remains in the treasury untouched, to be used as soon as operation on said system begins.

EXPENDITURES.

The expenditures upon this system, including all payments on account of contracts during the twelve months ending Sept. 30, 1894, amount to $1,115,190.19. This, with the amount previously reported, $2,834,526.12, makes the total expenditures to date $3,949,716.31. Your attention is called to the tables submitted herewith for matters of detail.

CHARLES RIVER VALLEY SYSTEM.

There is little to report of this system beyond its steady operation and the settlement of land damage with sundry parties during the year. Table D in the Appendix contains a full statement of the cost of operation for the year ending Sept. 30, 1894, and the following settlements for land damage have been made: —

John Gleason of Watertown, with Thomas and Mary O'Keefe, both of New York, by a deed dated Sept. 19, 1893 (recorded in Middlesex South District Deeds, book 2242, page 10), released to the Commonwealth "rights, privileges and easements" in Watertown, included within a taking made by this Board dated March 7, 1891, and recorded in Middlesex South District Deeds, book 2030, page 121. By a deed dated Oct. 30, 1893, Eben D. Jordan quit-claims to the Commonwealth "rights, privileges and easements" in and to a certain parcel of land in Boston (Brighton), included within the taking of this Board dated Sept. 10, 1890, and recorded in Suffolk Deeds, book 1955, page 516. This deed is recorded in Suffolk Deeds, book 2168, page 222. James A. Hathaway, by a deed dated Feb. 16, 1894, releases the Commonwealth, its officers, agents and servants, from all claims and demands by reason of the taking of this Board dated Sept. 10, 1890, and recorded in Suffolk Deeds, book 1955, page 516. This deed, which is recorded in Suffolk Deeds, book 2186, page 48, covers a portion of the sewer location in Brighton, extending through Bertram Street and private land east of Rena Street.

The following cases, reported in our last annual report as pending in the superior court in Suffolk and Middlesex counties, have been settled upon executions from said court: —

Frederick Ayer, a strip of land adjoining the Back Bay Fens, formally taken by this Board by deed dated Oct. 11, 1890, recorded in Suffolk Registry, book 1962, page 36. Francis W. Lawrence, Geo. Wheatland, Jr., and the Lawrence Land Trust (Francis W. Lawrence and William Minot, Jr., trustees), for land on St. Mary's Street, Brookline and Boston, taken Aug. 2, 1890, by deed of this Board, recorded in Suffolk Registry, book 1948, page 497, and also in Norfolk Registry, book 641, page 328. On March 24, 1894, George F. Livermore of Newton, who had brought action against the Commonwealth for damage to his land in that city, included within the taking of this Board dated March 7, 1891, and recorded in Middlesex South District Deeds, book 2030, page 121, agreed with this Board regarding said damages, accepted compensation and acknowledged judgment satisfied. Negotiations are pending regarding the various parcels of land belonging to the Boston & Albany Railroad Company on the line of their road at the corner of Essex Street and Commonwealth Avenue, Boston, Beacon Park, North Beacon Street, Brighton, and part of location in Newton, that appear likely to be amicably settled without the intervention of the court. This leaves the following cases still pending in court: —

Suffolk County: Butchers' Slaughtering and Melting Association, Brighton; John E. Cassidy, Brighton. Middlesex County: John E. Cassidy, Newton; Walter U. Lawson, Newton; Albert Brackett, Newton.

In addition to the connections stated in our last annual report, the towns and cities embraced within this system have made connections with the metropolitan sewer as per accompanying table: —

Connections made with the Metropolitan Sewer in the Charles River Valley from Sept. 30, 1893, to Sept. 30, 1894.

DATE.	City or Town.	Location of Connection.	Size.
Oct. 6, 1893, .	Boston (Brighton), .	The Abattoir, ...	15 inch.
May 30, 1894, .	Boston, . . .	Huntington Avenue, near Parker Street.	12 inch.
July 31, 1894, .	Boston (Brighton), .	Parsons Street, opposite Taylor's mill,	24 inch.

These, with the connections previously reported, show thirty connections made with the metropolitan sewer by the towns and cities embraced within this system, which are distributed as follows: Boston, seven; Brookline, one; Boston (Brighton), eleven; Watertown, four; Newton, six; Waltham, one.

The expenditures upon this system, including all payments on account of contracts during the twelve months ending Sept. 30, 1894, but not including expenses of operation (which are particularly stated in Table D of the Appendix), amount to $25,369.13. This, with the amount previously reported, $708,669.30, makes $734,038.43 as the total expenditures to date.

Your attention is called to tables submitted herewith for matters of detail.

During the year $15,864.20 has been expended that is chargeable to both systems in general, which amount, added to that formerly reported, $28,780.82, makes $44,645.02 so spent to this date. The expenditures of this Board to date may be stated concisely thus: —

North metropolitan system,	$3,949,716 31
Charles River valley system,	734,038 43
Both systems,	44,645 02
	$4,728,399 76
Engineering, administrative and contingent expenses,	160,473 55
Total expenditures to date,	$4,888,873 31

GENERAL — BOTH SYSTEMS.

The following communication to the Legislature was sen to the secretary of the Commonwealth Jan. 26, 1894, and by him duly transmitted to the General Court then in session: —

COMMONWEALTH OF MASSACHUSETTS.

To the Honorable the Senate and the House of Representatives.

The Board of Metropolitan Sewerage Commissioners respectfully reports that the sum of money provided by chapter 439 of the Acts of 1889 for the construction of the metropolitan sewerage system will not be sufficient to complete the work contemplated by said act. A careful estimate discloses that an increase of ten per cent. on the original appropriation will be required for this purpose. This increase is due in part to the following causes: The original estimate provided for a sewer of sufficient capacity to dispose of the sewage of the whole district included in the metropolitan system for a period of forty years. The probable increase of population in this district for the period mentioned was calculated from the census of 1885 and those prior to that time. When the census of 1890 appeared, it was learned that the percentage of increase was greater than had been estimated, and accordingly the capacity of the sewer was increased ten per cent. The construction of a sewer, which was not included in the original estimate, was required parallel to the Mystic Valley sewer. There has been a material advance in the cost of labor, skilled and unskilled, and a reduction in the number of hours constituting a day's work. The obstructions and difficulties, such as must be expected in doing work below the surface of the earth, have been many and serious, and furnish an additional reason for increased cost in construction.

The Board respectfully asks for such legislation as will provide the money necessary for the completion of the work.

(Signed) Hosea Kingman,
Tilly Haynes,
Harvey N. Collison,
Metropolitan Sewerage Commissioners.

110 Boylston Street, Jan. 26, 1894.

In response to the foregoing, the Legislature in April last passed an act, chapter 307, Acts of 1894, authorizing the treasurer and receiver-general to issue scrip or certificates of debt in the name and behalf of the Commonwealth and under its seal to an amount not exceeding five hundred thousand dollars. This act was approved April 25, 1894, and increases the amount of the metropolitan sewerage loan to five and one-half million dollars; the additional half million dollars maturing at the same time as the original five million, and the requirements of the sinking fund and interest being met in the same manner as the other, excepting that it is payable after thirty-six instead of forty years.

In our last annual report attention was called to the fire of March 10, 1893, which destroyed the Ames building on Lincoln Street, Boston, in which the offices of this commission were then located. The property of the Commonwealth, beyond the contents of the safes in the office, was destroyed; and the attention of the Legislature being called thereto, by chapter 81 of the Resolves of 1893, a sum not exceeding $4,500 was allowed to this Board for the purchase of furniture and furnishings for the offices of the Board. Of this amount there has been expended to date (Oct. 1, 1894) $3,298.63, leaving a balance unexpended of $1,201.37. Against this, bills amounting to $101.60 are still outstanding, which will be settled before the close of the present year, and leave a balance unexpended amounting to $1,099.77.

The lease of the rooms in the Walker building, 110 Boylston Street, Boston, expired on the fifteenth day of March, 1894, and were renewed by this Board for a term of one year, at the same rate, — $3,050.

The annual meeting of the Board was held as provided by the act on the first Monday of February (February 5), 1894, and Hosea Kingman of Bridgewater was chosen chairman and Edward P. Fisk of Boston clerk, for the year.

Tilly Haynes of Boston was appointed by the governor and confirmed by the council as his own successor on this Board for three years from the first Monday in January (January 1), 1894.

The Appendix contains tables showing in detail the receipts and expenditures for the year, also the assets and liabilities at date.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Metropolitan Sewerage Commissioners.

BOSTON, Oct. 1, 1894.

REPORT OF THE CHIEF ENGINEER.

REPORT OF THE CHIEF ENGINEER.

Boston, Sept. 30, 1894.

Hosea Kingman, Tilly Haynes, Harvey N. Collison,
Metropolitan Sewerage Commissioners.

Gentlemen: — In accordance with your wish, I give a very brief sketch of the work done on the metropolitan system in preceding years, followed by a detailed account of the work done during the last year. Your first annual report, dated Sept. 30, 1889, merely stated that the Board had just organized, and that the matter of the appointment of an engineer was receiving attention. A chief engineer was appointed during the latter part of October, 1889, and assistants during the following month. During the winter and spring of 1889–90 surveys and studies were made on Deer Island, in Winthrop, in East Boston and in the lower part of the Charles River valley.

The work of construction was begun at the lower ends of the north metropolitan and of the Charles River valley systems in May and June, 1890, four and one-third years ago. By September 30, work was in progress at various points from Huntington Avenue, Boston, to Waverly Street, Brighton, and from the middle of Deer Island to Chelsea River, excepting the siphons and pumping stations.

YEAR ENDING SEPT. 30, 1891.

North Metropolitan System. — Of that portion of the main line extending from near the southerly end of Deer Island, through Winthrop, East Boston, Chelsea, Everett and Medford, to near Medford Square, nearly one-half was completed, and the balance, except the siphons and pumping stations and a part of the sewer in Chelsea, was under construction. Work was also begun at the lower ends of the Cambridge and Melrose branches. The wharf at Deer Island was completed during the winter.

Charles River Valley System. — All of this line from Huntington Avenue, Boston, through Brookline, Brighton, Newton, Watertown and into Waltham, was under construction, and three-fourths of it was completed.

YEAR ENDING SEPT. 30, 1892.

North Metropolitan System. — Work on the main sewer was pushed nearly to the lower Mystic Lake in West Medford, and, excepting the siphons, pumping stations and outfall, a comparatively small portion of the main line remained to be done. Work on the siphon at Chelsea River was begun this year. The remaining part of the Melrose branch, and the Cambridge branch as far as Main Street, Cambridge, was put under construction, except the siphon and pumping station at Mystic River.

Charles River Valley System. — This system was completed during the winter, and was put into operation early in the spring of 1892.

YEAR ENDING SEPT. 30, 1893.

Construction was begun at various points on the main line from near the lower Mystic Lake to the extreme upper end in Stoneham; the entire Alewife Brook line (except the siphon and pumping station); the balance of the Cambridge branch and the lower part of the East Boston branch.

Owing to the difficult and costly work which the outfall and various siphons promised to be, and because of the risks and uncertainties attendant thereon and the liability of change of plans to meet varying conditions, it was deemed wise to have the construction carried on under the immediate direction of the engineering department, instead of by contract. The siphon at Belle Isle Inlet had been let by contract before this determination was arrived at. Accordingly work on the outfall at Deer Island and the siphons at Shirley Gut and Mystic River were entered upon. The siphon at Chelsea River, which was started at the close of the previous year, was pushed to completion, as was also the deeper part of the Shirley Gut siphon. Day work of less magnitude was also entered upon at three other localities.

YEAR ENDING SEPT. 30, 1894.

During the year just closed, work by contract has been begun and is well under way in the following localities: From Marginal Street through Eastern Avenue, Chelsea; through and around the borders of East Boston; around the southerly and easterly sides of Charlestown; through Mystic Avenue, Somerville; and the Cummingsville Branch, in Winchester.

The contractors who are building the pumping station-houses at Deer Island and East Boston have nearly completed their work. The engine and boiler house for the Charlestown station have just been begun. Day work on the foundations and connections at Deer Island and East Boston pumping stations was begun this year and is now nearly finished, and that on the Charlestown station is well under way. The important work on the outfall and siphons started last year has been continued. The siphons at Malden River, Abbajona River and the upper Mystic River were begun and are being built by day work for the reasons mentioned in the sketch of the work for 1893. The only portions of the entire system not yet completed or under actual construction are the small pumping station for the Alewife Brook line and three spurs on the same line, covering a total distance of about 1,700 feet. Studies and plans have been made for doing that work. The blue lines on the accompanying map show the portions of the system remaining to be done September 30. It is entirely probable that the outfall at Deer Island, the gaps at Belle Isle Inlet, Malden River and the upper Mystic River will be substantially completed before Christmas. If a map should be made to represent the progress to Jan. 1, 1895, the blue lines would very nearly disappear.

Detailed statements of the work for this year are given in the following pages.

Section 1 (Day Work), Outlet Deer Island.

Location. — From a point about 60 feet inside of high-water line, on the south-westerly shore of the island, following the westerly side of Deer Island Spit to a point about opposite the Deer Island Spit light.

Length of section, about . . . . 1,925 feet.

Diameter of sewer, 6 feet 3½ inches.

Note. — Owing to the two totally different methods employed during this year, the report concerning Section 1 is divided into two parts.

Oct. 1, 1893, to April 30, 1894.

Location. — The work is a continuation of that described in the fifth annual report for this section, and extends along the westerly side of Deer Island Spit 600 feet out into the ocean.

Assistants.

Assistant Engineer: Laurence Bradford.
Superintendent: Charles G. Craib.
Foreman: Benjamin L. Sykes.
Transitmen: Principal — Frank E. Winsor.
" Assistants — Nathan B. Wilber, George A. Winsor.
Pile driving by Josiah Shaw.

Method Employed. — Coffer-dam, pumping plant and method of excavating were each similar to that described in last year's report.

Progress. — Coffer-dam and excavation were extended from Station 5 + 26 to Station 6 + 90. Masonry was completed from

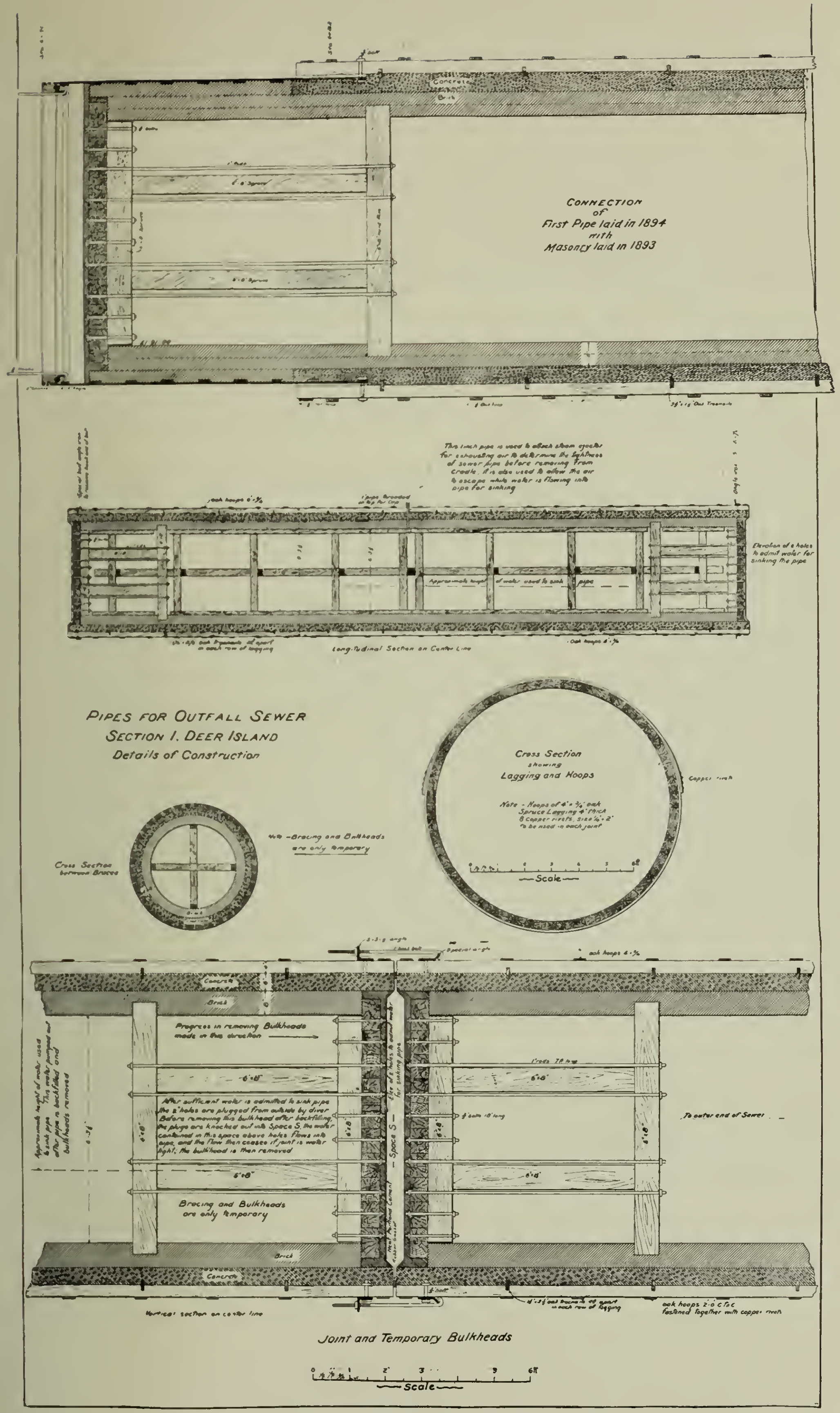
Station 4+50 to Station 6+74. Station 0 is near the southerly shore of Deer Island. The stations increase in going southerly, towards the outlet.

Cost. — From June 21, 1893, to Sept. 30, 1893, the work had cost about $33,000, and by June 30, 1894, the cost had increased to about $59,000. The cost per foot before Oct. 1, 1893, was about $70. The cost per foot of entire work done between June 1, 1893, and May 1, 1894, was about $90.

The progress during October, 1893, was slow, owing to the difficulty in sinking the pump-well at Station 6. From Oct. 14, 1893, to Oct. 30, 1893, no brickwork was laid, owing to the leakage from the sea. During the busy part of this period (Oct. 1, 1893, to Jan. 12, 1894) there were three 6 inch centrifugal pumps and one 9 inch centrifugal pump in constant operation. The greatest rate of pumping was 6,000,000 gallons in twenty-four hours. The pumps were moved to the well at Station 6 on October 20.

As the work progressed the difficulties increased. The porous nature of the ground allowed the sea water to pass beneath the sheet planking at the sides and come up into the trench. Work could be done only at low water. Frequently, after hours of hard, continuous pumping, the trench could not be sufficiently freed from water to permit masonry construction. No excavating was done after November 27. On December 14 the masonry was completed to Station 6+74.

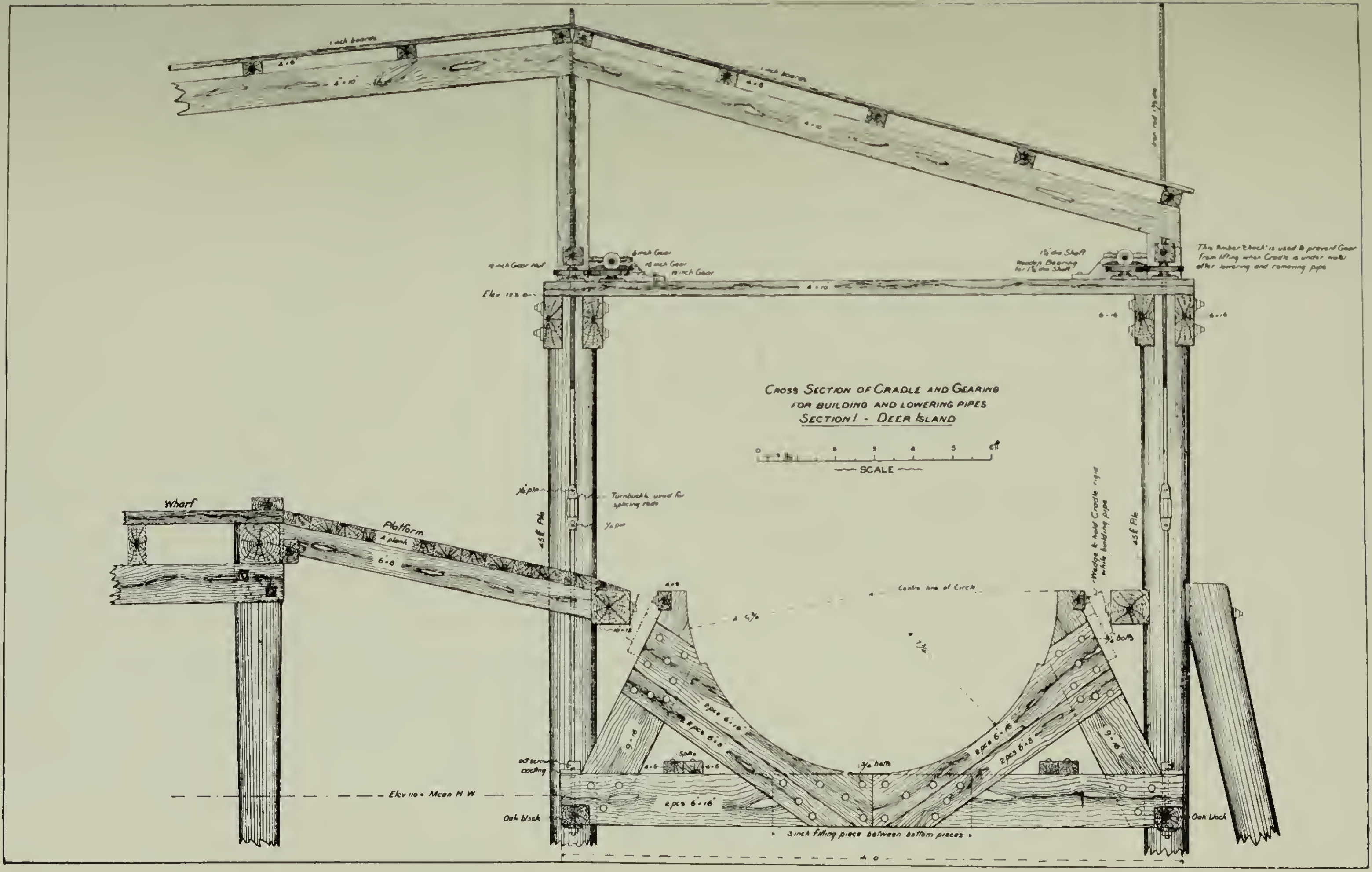
Temporary End. — An annular ring of hard pine, 12 inches wide and 9 inches thick, having an interior diameter of about 7 feet, was fastened to the end of the completed masonry by means of anchor bolts running back into the concrete. This ring (which remains a part of the completed work) had 34 hook-bolts ¾ inch diameter, with hook end placed in readiness to be attached to the work completed later. A bulkhead of 6 inch hard pine plank was then fitted inside this annular ring by means of a Z bar ring, and the whole was securely braced and bolted to temporary timbers built in the brickwork. This bulkhead was covered on the outside by a 2½ inch thick neat Portland cement face. A temporary opening (through which a suction pipe for a 6 inch centrifugal pump extended) in the arch of the sewer, about 15 feet back from the bulkhead, was temporarily covered by hard pine plank 6 inches thick, fitted to brickwork, and this plank covered with Portland cement concrete. This suction pipe extended up through the concrete back-filling, and was left, securely plugged, for connecting to a pump during 1894. No work was done on the section between Jan. 12 and May 1, 1894.



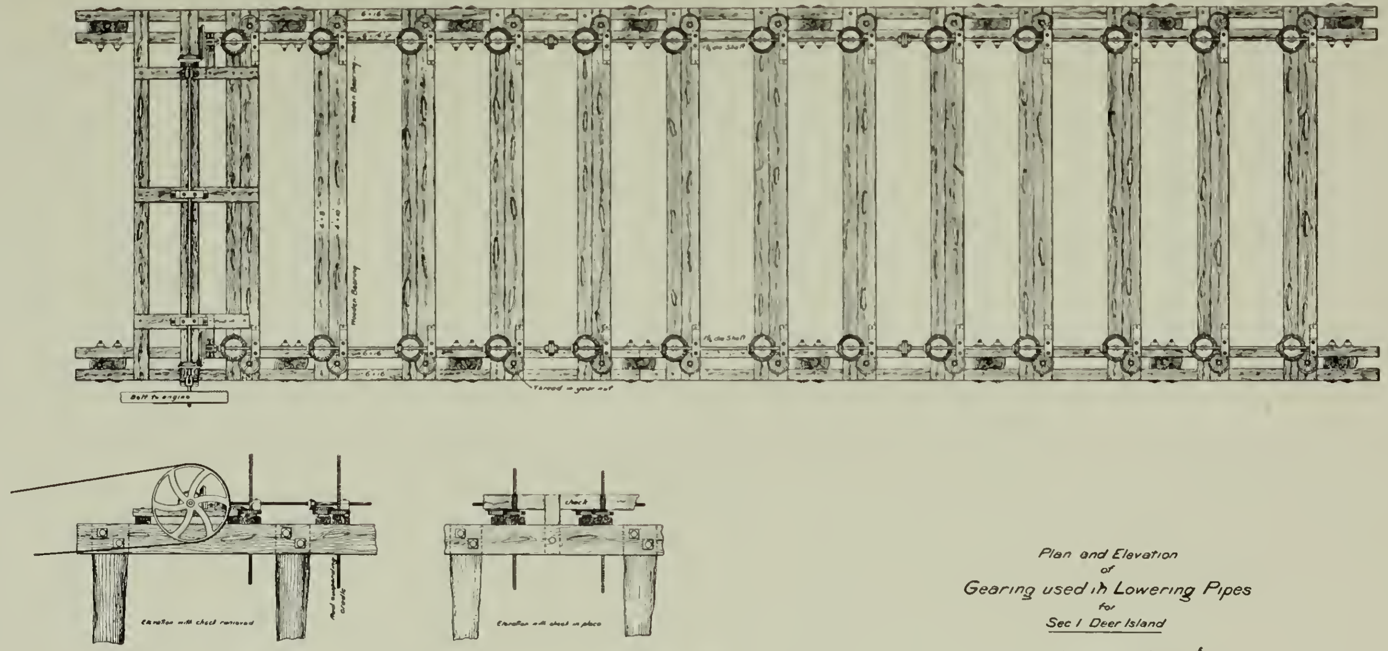
PIPES FOR OUTFALL SEWER
SECTION I. DEER ISLAND
Details of Construction

Connection of First Pipe laid in 1894 with Masonry laid in 1893
Concrete
Brick
6'-8" Spruce
Oak hoops
3½" x 1½" Oak Treenails
This inch pipe is used to attach steam ejector for exhausting air to determine the tightness of sewer pipe before removing from cradle. It is also used to allow the air to escape while water is flowing into pipe for sinking
Oak hoops 4" x ¾"
Elevation of 2 holes to admit water for sinking the pipe
Approximate height of water used to sink pipe
Longitudinal Section on Center Line
Oak hoops 4" x ¾"
Cross Section showing Lagging and Hoops
Copper rivets
Note - Hoops of 4" x ¾" oak
Spruce Lagging 4" thick
8 copper rivets, size ¼" x 2" to be used in each joint
Scale
Cross Section between Braces
Note - Bracing and Bulkheads are only temporary
Special angle
Oak hoops 4" x ¾"
Concrete
Brick
Progress in removing Bulkheads made in this direction
6"x8"
6"x8"
After sufficient water is admitted to sink pipe the 2" holes are plugged from outside by diver. Before removing this bulkhead after backfilling, the plugs are knocked out into Space S. the water contained in this space above holes flows into pipe, and the flow then ceases if joint is water tight; the bulkhead is then removed
Approximate height of water used to sink pipe. This water pumped out after pipe is backfilled and bulkheads removed
Bracing and Bulkheads are only temporary
Neat Portland Cement
– Space S –
Elev. of 2" holes to admit water for sinking pipe
6"x8"
To outer end of Sewer
Brick
Concrete
Vertical section on center line
oak hoops 2'-0" c to c fastened together with copper rivets

Joint and Temporary Bulkheads

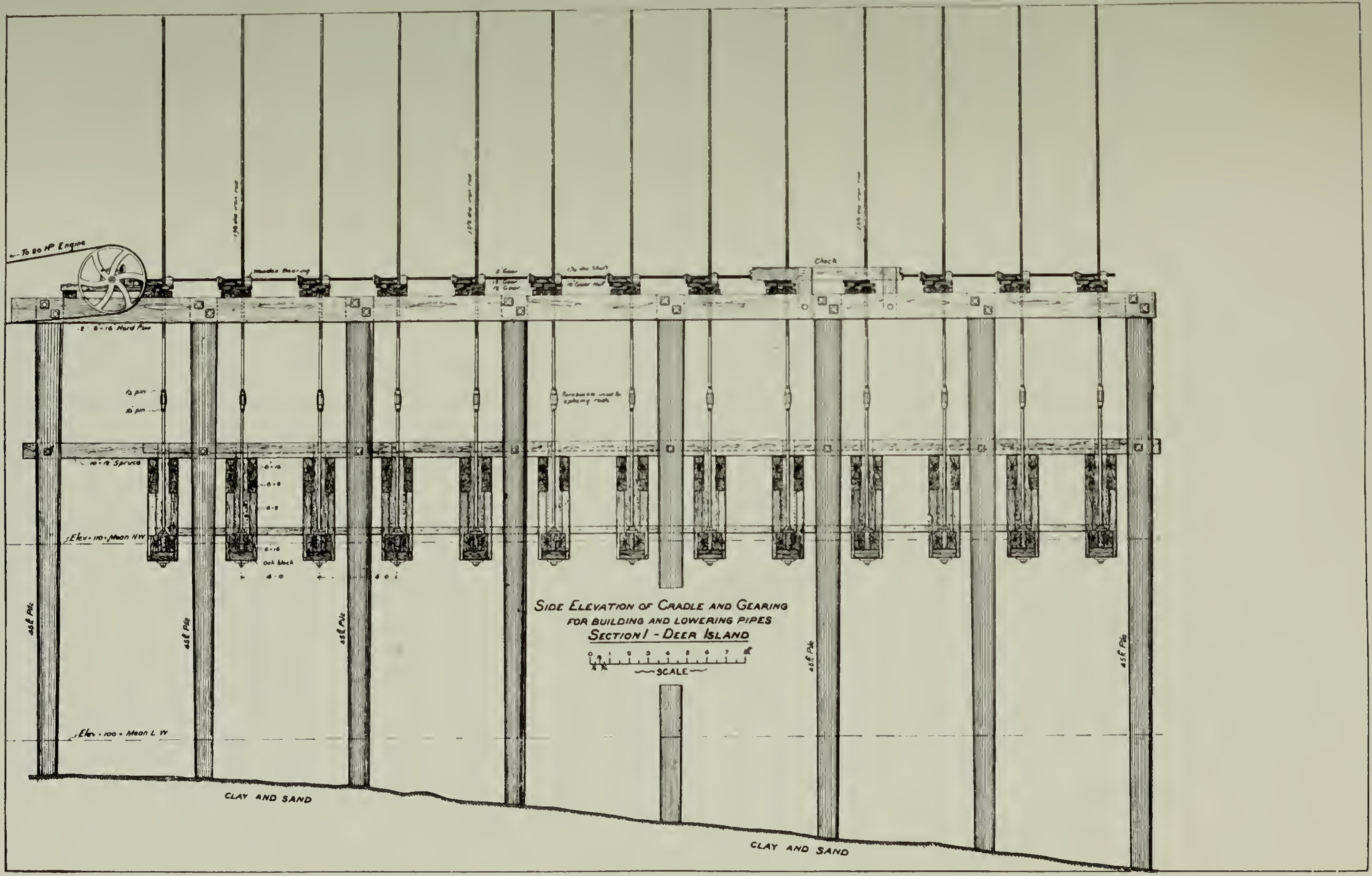


CROSS SECTION OF CRADLE AND GEARING
FOR BUILDING AND LOWERING PIPES
SECTION I - DEER ISLAND

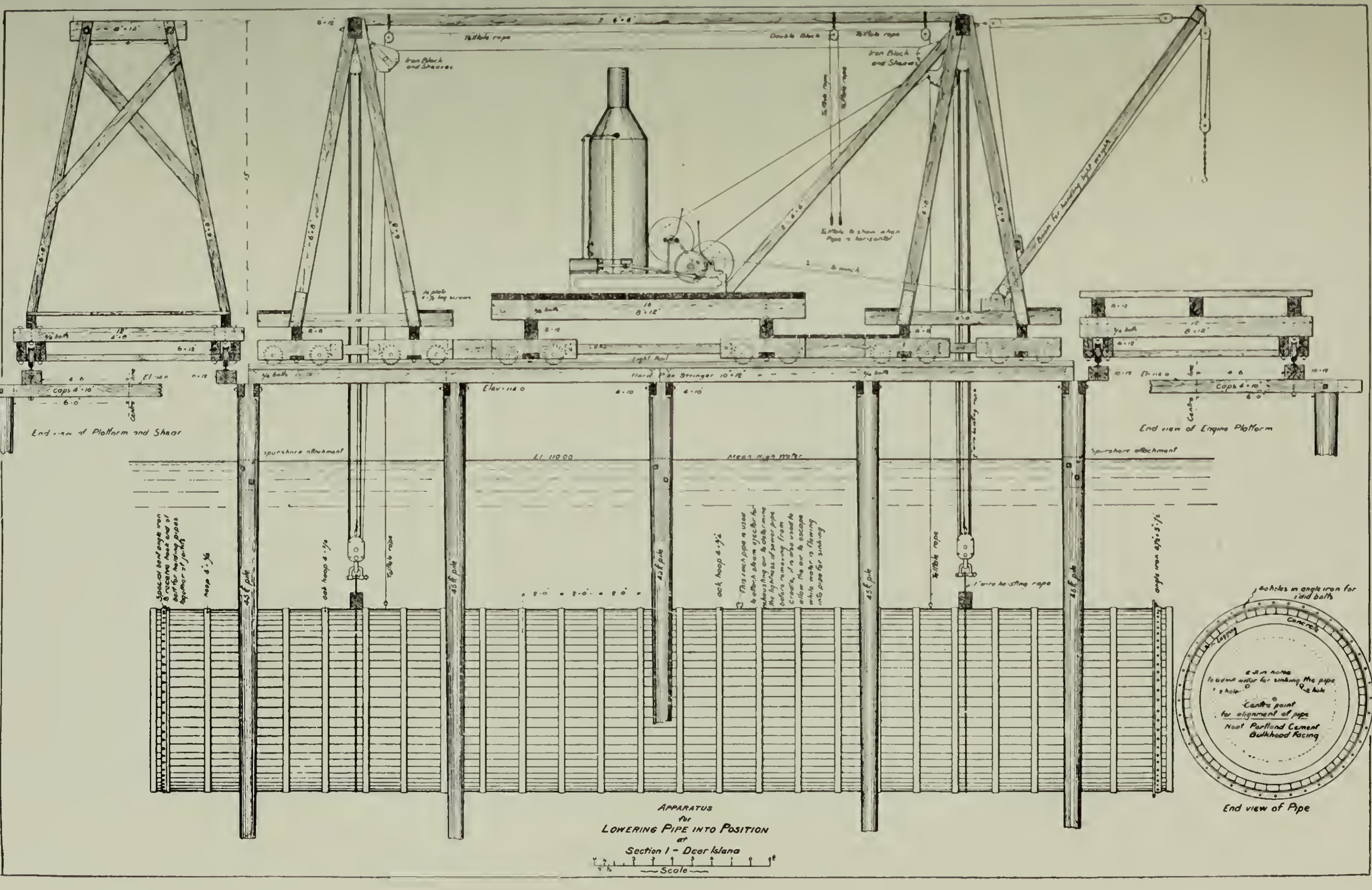


Plan and Elevation
of
Gearing used ih Lowering Pipes
for
Sec I Deer Island

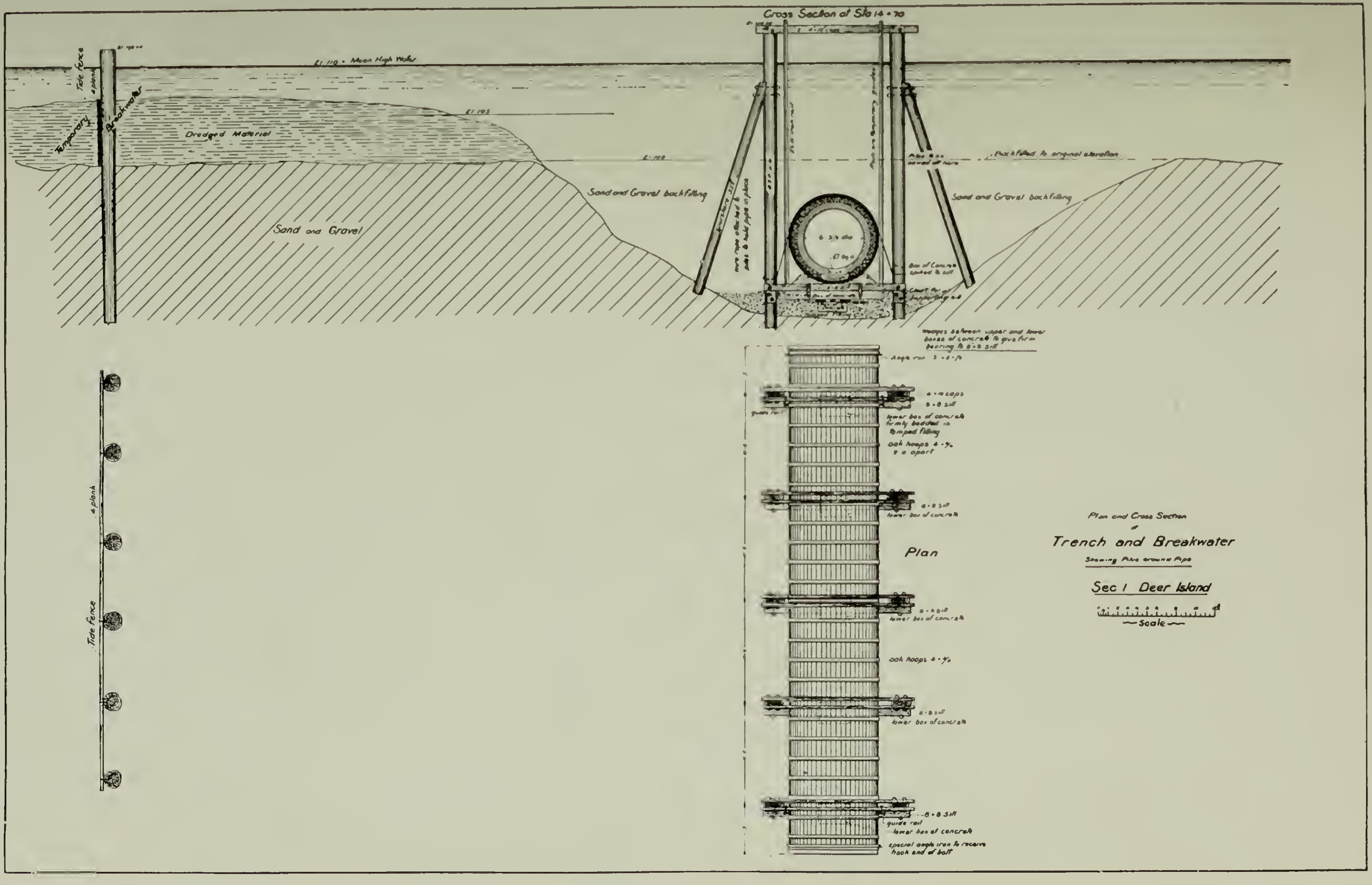
~~ Scale ~~



SIDE ELEVATION OF CRADLE AND GEARING
FOR BUILDING AND LOWERING PIPES
SECTION 1 - DEER ISLAND


6·12
Tailble rope
Iron Block and Sheaves
Double Block
Tailble rope
Iron Block and Sheaves
Beam for handling light weights
Tailble & shown when Pipe is horizontal
8 winch
6·8
6·8
16
8·12
Light Rail
Hard Pine Stringer 10·12
Elev. 114·0
3/4 bolts
12
6·12
caps 4·10
6·0
End view of Platform and Shear
caps 4·10
End view of Engine Platform
spurshore attachment
El. 110·00
Mean High Water
spurshore attachment
Special bent angle iron & receive hook end of bolt for hauling pipes together at joints
hoop 4·7/8
45 ft pile
oak hoop 4·7/8
Tailble rope
45 ft pile
45 ft pile
oak hoop 4·7/8
This inch pipe is used to attach steam ejector for exhausting air to determine the tightness of joints before removing from cradle, it is also used to allow the air to escape while water is flowing into pipe for sinking
45 ft pile
Tailble rope
1 inch hoisting rope
45 ft pile
angle iron 4·3·5/8
40 holes in angle iron for 1 inch bolts
Concrete
Lagging
2 inch holes to admit water for sinking the pipe
1 inch hole
2 inch hole
Centre point for alignment of pipe
Neat Portland Cement Bulkhead Facing
End view of Pipe
Scale

APPARATUS
for
LOWERING PIPE INTO POSITION
at
Section 1 - Deer Island

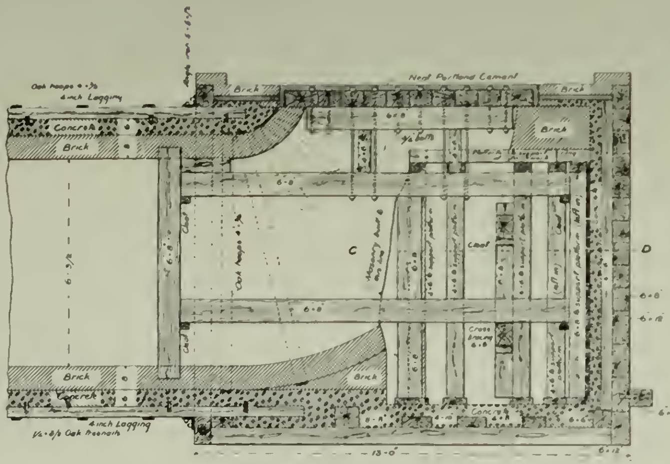


Plan and Cross Section
of
Trench and Breakwater
Showing Piles around Pipe

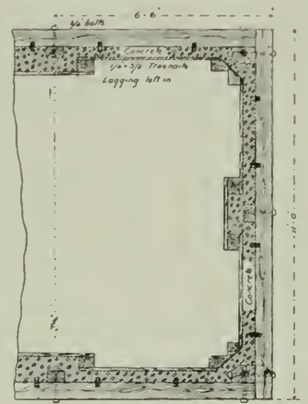
Sec 1 Deer Island

—Scale—

DESIGN FOR
OUTER END OF LAST PIPE
SECTION I - DEER ISLAND



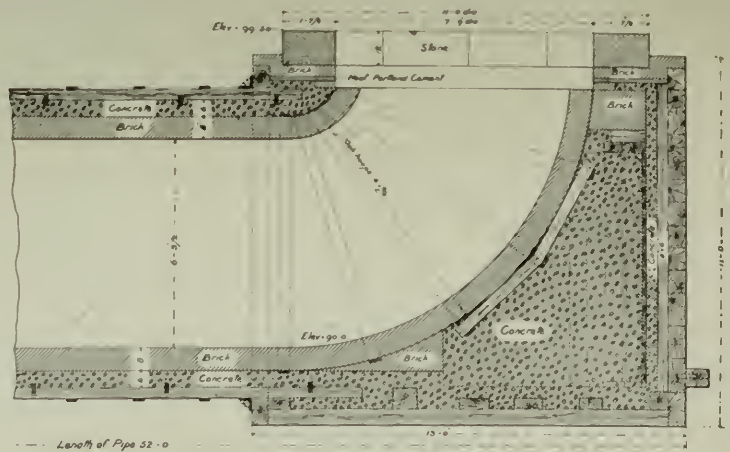
VERTICAL SECTION ON CENTRE LINE



PLAN ON LINE C-D
(BULKHEAD AND BRACING REMOVED)

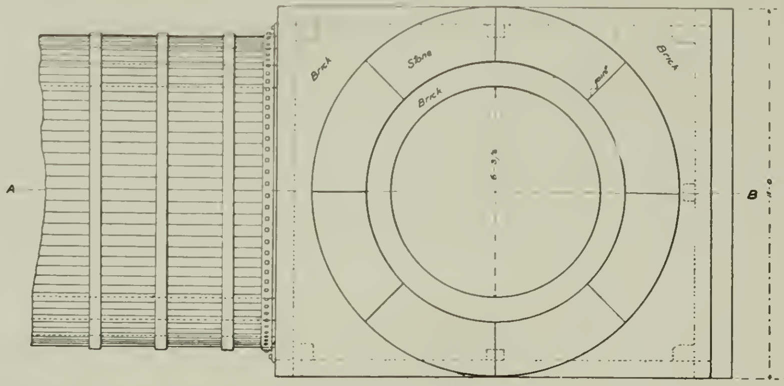
BULKHEAD AND BRACING
READY FOR LEAVING CRADLE

SCALE



VERTICAL SECTION ON LINE A B

OUTER END OF PIPE, COMPLETED



PLAN ON TOP

Accident. — Thomas Connelly fell into the trench (filled partly with water) on April 14, 1894, and received injuries from which he died the following day.

May 1, 1894, to Sept. 30, 1894.

The work done by coffer-dam, described above, progressed slowly and with considerable difficulty, for causes stated, and the expense was very considerable. It was concluded that in its extension this year it would be advisable to make use of a method somewhat similar to that adopted in building the sewer across Shirley Gut, described in last year's report. During the latter part of the winter and early part of the spring studies and experiments to that end were made. The sewer across Shirley Gut was made of pipes constructed out of brickwork incased with thin steel shells. It was thought that if these shells could be made of wood they would, when sunk in the harbor and covered with earth, last much longer than if made of steel, would cost considerably less, and would have other advantages. It may be stated, however, that neither the steel nor wooden shells are necessary for the permanency of either of these works. Experiments were made by Assistant Engineer William W. Lewis to test the points above mentioned. The strength to resist bursting pressure of oak hoops joined with copper rivets was determined. A pipe about 16 feet long, with an external diameter of 5 feet 2 inches, made of 2 inch by 4 inch spruce lagging, with an inner shell of Portland concrete masonry 8 inches thick, and with an interior clear diameter of 3 feet 6 inches, was made at Chelsea Creek and bulkheaded. It was found that a vacuum of 14.5 inches was very quickly and easily obtained, showing it to be water-tight. The following further tests were made of this pipe: it was placed on a cradle and slid down to the beach at low tide, and allowed to remain for several days. After each high tide it was examined for leakage, and found tight. In taking it up from the beach it was rolled on its sides over timbers. No cracks developed, nor did any when the pipe was supported by its ends. This pipe was of the right size to use for the Malden River siphon, but the experiments and studies indicated the feasibility of the use of a much larger one at the Deer Island outlet. Studies to this end were made by Mr. Lewis, and more detailed ones by Mr. Frederick D. Smith, under the direction of the writer. As a result of the studies and experiments, the design of pipe and method of constructing and laying it, described above and in the following text and shown by accompanying drawings, was decided on.

Another marked difference in the method of construction of the outlet sewer and that of the Shirley Gut siphon will be noticed. In the Shirley Gut siphon the pipe sections were made on the beach, a little above high water, and were launched by moving them down the beach on rails, rollers and blocking at low water. They were partly hoisted and partly pulled off the rollers, blocking and rails on the second following high tide, and were then towed to the proper position to place in the siphon.

The pipe sections for the outlet were made in " cradles " at the sides of the new wharf. These cradles, as will be seen by the drawings and the description later on, were each made strong enough to hold the pipe sections 52 feet long and weighing upwards of 210,000 pounds. These cradles could be lowered by machinery at will and thus place the finished pipe in the water, where it could be towed to the outlet, distant between one-half and three-fourths of a mile.

Location. — From Station 6 + 74 (this being the end of the work finished by coffer-dam process), and extending along the westerly side of Deer Island Spit. At present (Sept. 30, 1894) the pipes are laid to Station 15 + 06, and pipe is built and trench prepared for 68 feet additional.

Assistants.

Assistant Engineer: Frederick D. Smith.
Foreman of construction of pipes: John Craib.
Foreman of dredging, preparing trench and laying of pipes: Chris Rasmussen.
Diving by Hiram M. Phillips.
Dredging by Eastern Dredging Company.
Pile driving by Josiah Shaw.
Draughtsman and Principal Transitman: John H. Gregory.
Assistant Transitman: J. T. P. Jones.

Trench.

The pipes were laid in a trench dredged to the following dimensions: —

Average depth below mean low water,	16 feet.
Average depth below mean high water,	26 "
Average width at bottom,	12 "
Average width at top,	60 "
Average excavation per linear foot of trench,	20 cubic yards.
Length completed, ready for pipe,	900 feet.

Work on trench begun June 9, 1894.

Character of Excavated Material. — Sand and gravel, with stratum of black mud mixed with sand.

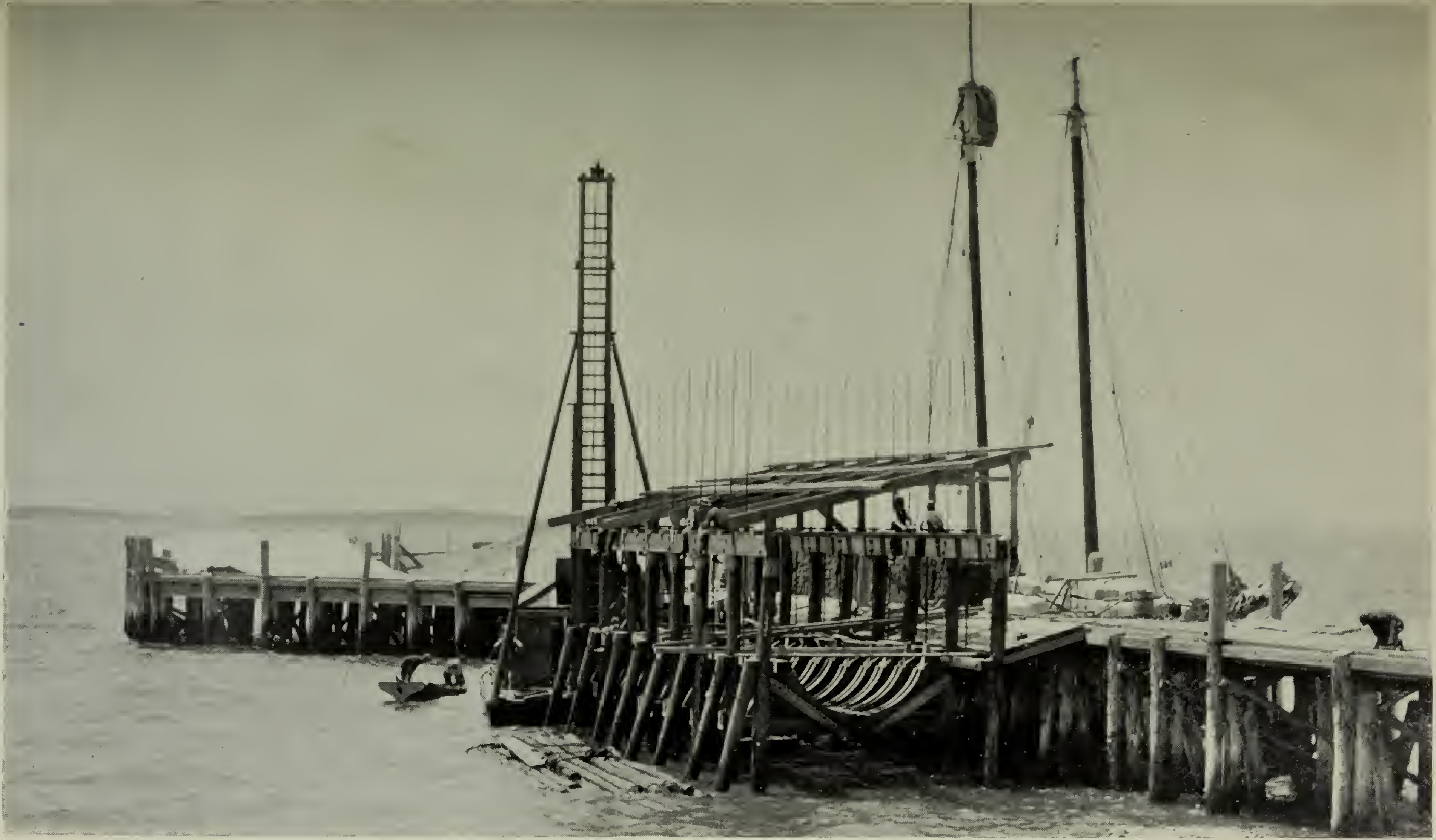
Cost of dredging,	$12,050 00
of dredging per linear foot,	13 40

Pile Work in Trench.

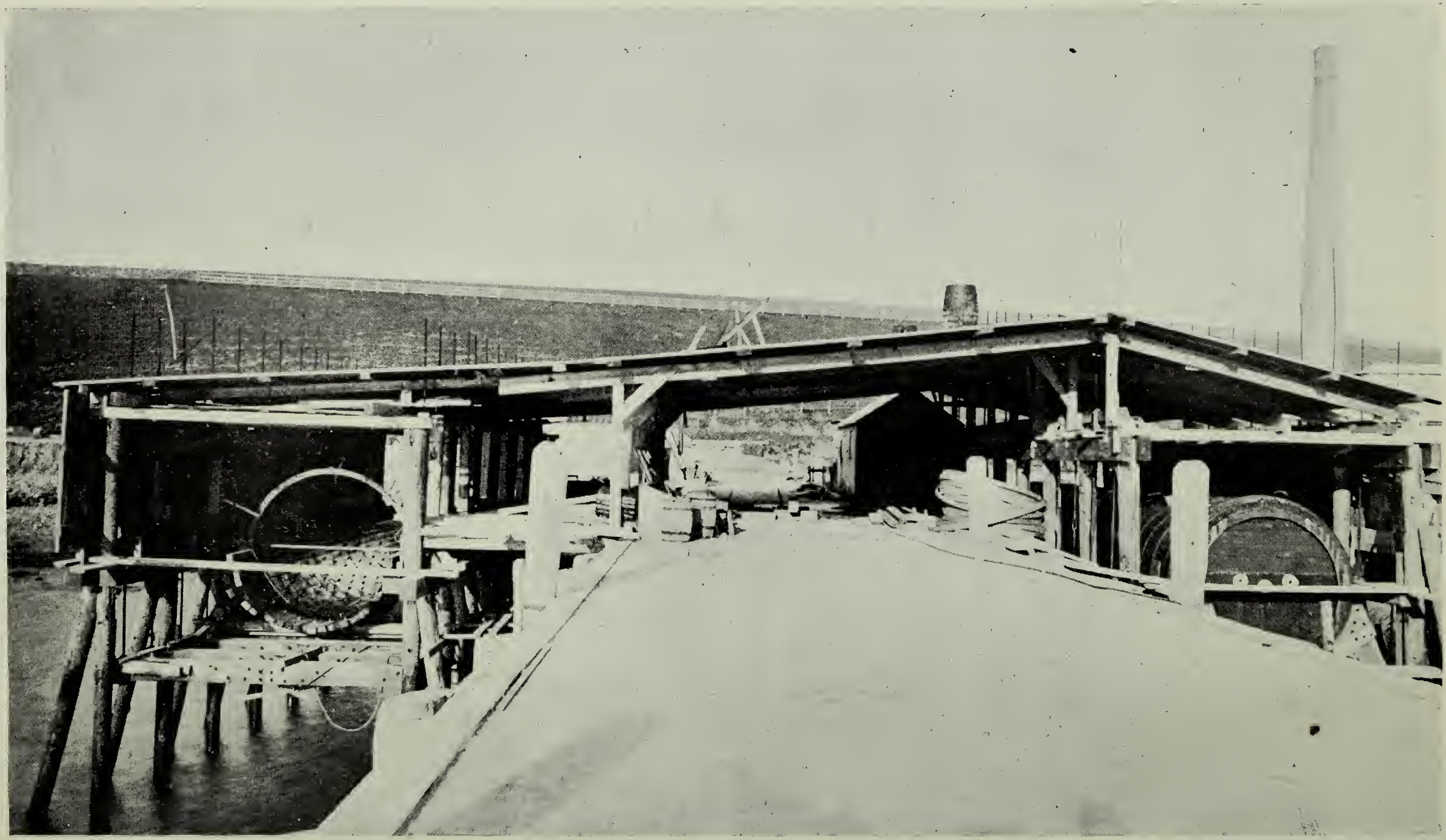
Cost for piles and labor,	$3,400 00
for caps and bolts,	200 00
per linear foot for same,	4 00

Sills.

Cost of labor and materials,	$840 00
per linear foot for same,	94



Section 1, Deer Island. One of the Cradles in which Pipe Sections are built. June 1, 1894.



Section 1, Deer Island. Cradles at Wharf.

Cradles for building Pipe Sections.

Cost of piles and labor on same,	$600 00
of materials and equipments,	1,800 00
of labor,	1,300 00

Pipe Sections.

Character of Structure. — Masonry pipes encased in wood lagging securely hooped. These laid in sections and bolted together by divers.

Description of a single pipe: —

Length,	52 feet.
Greatest diameter (outside),	10 feet 1½ inches.
Thickness of brickwork,	8 inches.
of concrete,	6 inches.
of spruce lagging,	4 inches.
Hoops (white oak),	4 inches by ¾ inch.
Total thickness of pipe,	18 inches.
Internal diameter,	6 feet 3½ inches.
Weight of pipe in air,	210,000 pounds.

Cost of building Pipe Sections.

Brickwork (including labor),		$5,880 00
Concrete (including labor),		3,940 00
Other labor,		9,000 00
Spruce lagging,		1,530 00
Iron angle hoops for fastening sections together,		970 00
Oak hoops for holding structure together,		280 00
Bulkhead material,		600 00
Approximate cost per linear foot of pipe,		24 70
Approximate cost per cubic yard of brickwork,		11 70
Approximate cost per cubic yard of concrete,		8 40
Cost of towing pipe sections from wharf to outfall,		$200 00
of lowering pipe section into trench { labor,	$690 00	
apparatus,	300 00	
		990 00
of diving (for preparing foundations, bolting pipes together, etc.),		1,200 00

Miscellaneous Expenses.

Tools, coal, rentals, lumber, rubber gaskets, bolts, car fare, expressage, etc.,	$3,940 00

Back-filling. — Up to this time, material dredged from trench has been carried back and dumped over pipe at no extra cost.

Condition of Work on Sept. 30, 1894.

Pipe laid,	832 feet.
Pipe completed at wharf,	52 "
Equivalent of partly-made pipe,	16 "
Pipe completed,	900 "

Trench prepared for pipe, sills set, etc., for distance of 900 feet (from Station 6 + 74 to Station 15 + 74).

Trench dredged to grade for 300 feet beyond (to Station 18 + 74).

Trench back-filled to Station 14 + 00.

Trench partly back-filled to Station 14 + 55.

Approximate cost to date (September 30) per linear foot of excavation, masonry and wooden shell, including labor, material, pile foundations and miscellaneous expenses, $54.15.

A violent storm September 30 prevented the laying of 52 feet of pipe completed at wharf that day.

Because of the strong tidal current across the trench, it was necessary to construct a temporary break-water. This was parallel to, and located at first 75 feet and later 100 feet from, the centre line of trench on the east side. It was built by driving piles 8 feet apart, covering these longitudinally with 4 inch planking up to half tide, and filling dredged material on both sides. After the trench for the sewer was dredged, piles (45 feet) were driven in bents of two, there being 5 bents for each 52 feet length of pipe. Three bents of the five were spur-shored. These bents were capped at elevation 114 with 4 inch by 10 inch spruce girder caps, upon which stringers were laid to carry the lowering apparatus.

Sills. — Sills were made as follows, and secured to the bents of the piles by bolting : they consisted of 8 inch by 8 inch spruce which lay on top of a box of concrete. The box of concrete was fastened to the sill and was used to cause the sills to sink. Such a sill, when sunk, could be easily handled by the diver. The two end sills for each pipe had a circular cradle made of timber and concrete (to sink it) which fitted the pipe. Sills were blocked up and tamped until they were perfectly solid and had a firm bearing.

Vertical Guides. — To insure that the pipe should be lowered exactly into these cradles, vertical guides of tee-rails were placed with one end fitting into mortises in the sill.

Construction of Pipes. — Work began June 8. The pipes were built in cradles located at the new wharf, about one-half mile from trench where they were laid. The essential features of the cradles were : —

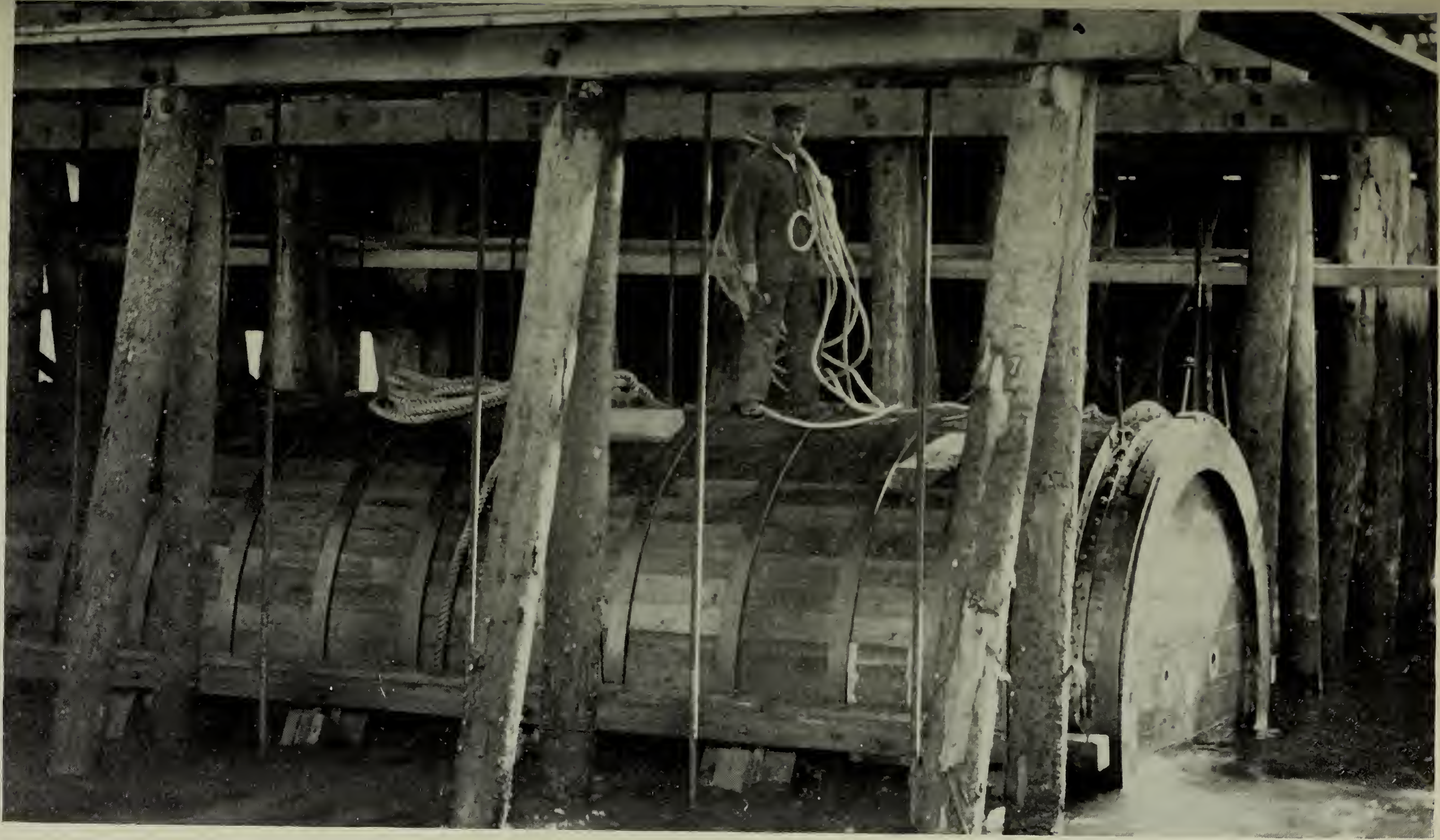
1. Thirteen strong ribs, each having a built up semi-circle of 9 feet 3½ inches diameter, each rib supported at each end by a 1½ inch steel rod, with thread which fitted a 12 inch diameter cast gear nut.

2. A system of gearing was used by which an engine ran the 26 gear nuts simultaneously, and thus raised or lowered the cradle equally in all parts. Four inch spruce lagging, 6 inches wide, was laid up to springing line and bolted to a steel angle hoop at each end of the pipe. These angle hoops were used to bolt together continuous sections of the pipes when laid. Treenails were put into the lagging and left projecting 2 inches into the space to be occupied by concrete. The whole inside of the wooden shell was then covered with a coating of heated wax tailings, so as to protect the wood from the possible action of free lime in the Portland cement concrete which was then put in. This shell of concrete was 6 inches thick, and mixed with volumes as follows : cement, 1 ; sand, 1½ ; beach gravel, 3½.

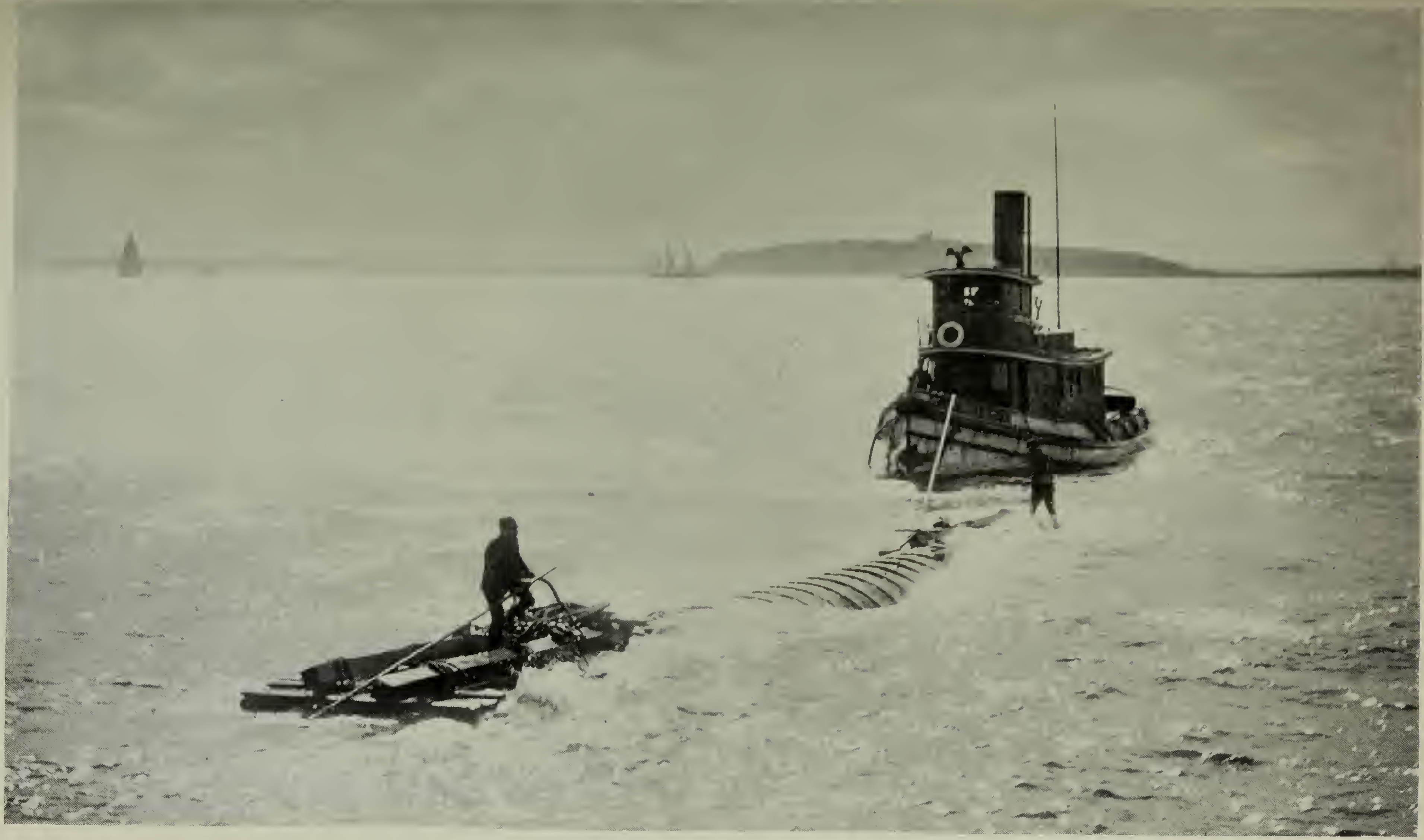
The best results appeared to come from concrete put in quite wet. Ordinary semi-circular forms and lagging were used to mould the concrete invert. After twelve hours' setting, the concrete was strong enough to remove forms and lagging, and put in brickwork, which was done as in an ordinary sewer trench. No brickwork was laid within one foot of either end, this space being left for fitting in bulkheads. The brick shell was 8 inches thick, and the inner ring was left toothed for making connection with adjoining pipes. After the brick arch was completed, the wooden shell was brought up at the sides and the concrete at the same time. Three widths of lagging at the top were temporarily left out the entire length, in order to rivet the hoops which were then put on. These hoops were 4 inch by $\frac{3}{4}$ inch oak, with two joints in each hoop. These joints were fastened by eight $\frac{1}{4}$ inch copper rivets in each joint. One joint was riveted, then the hoop was passed around the pipe and the last joint made at the top. To protect the copper rivets, the joints were first painted with a heavy coat of asphaltum varnish and then wound with cloth saturated with wax tailings. These hoops were placed two feet apart on centres. After the hoops were completed, the three widths of lagging at the top were put in and the space below filled with cement grout. After the pipes were braced internally 6 feet apart by both vertical and horizontal 4 inch by 6 inch braces, bearing on 4 inch by 6 inch stringers running longitudinally, the bulkheads were put in. The bulkheads were of 6 inch spruce, caulked and secured by 1 inch iron rods to vertical 6 inch by 8 inch posts built into the brickwork about 8 feet from each end of the pipe. The bulkheads were inside the concrete layer of the pipe, and were drawn against the brickwork by the iron rods. After the whole bulkhead had been caulked enough to prevent leakage of grout, another bulkhead (temporary) was put outside the former at a distance of three inches, and neat Portland cement grout poured in between, thus forming a grout casing completely filling all crevices in the bulkhead and rendering it substantially air-tight. In the forward end of each section of sewer pipes two 2 inch wrought iron pipes, to be used later to let in water, were placed so as to extend quite through the entire bulkhead. These pipes were plugged from the inside, when first made, with pine. After a masonry pipe section was sealed up it was examined for tightness by partially exhausting the air. The least perfect vacuum recorded on any pipe was 6 inches of mercury; the best was 13½ inches. This exhaustion was by means of a steam ejector connected to a 1 inch pipe which extended through the entire shell of the pipe section, about midway of length and near the top. This pipe was also used to allow air to escape when letting in water to sink the pipes. The pipe as thus completed was painted with asphalt to protect the wood from limnoria and teredo before it could be covered in the trench with earth. A rubber gasket 1 inch thick and 2½ inches wide, having an exterior diameter of 8 feet 5½ inches, was then fastened to the end of the pipe by nailing it to the wooden shell. The pipe was then ready for launching.

Launching. — The pipes were launched by lowering the pipes and cradles into the water at high tide. This was done by means of the 26 screws previously alluded to. A gear nut on each was driven by a train of gears and shafting which was connected to a 20 horse-power engine. In this way the lowering was uniform, and no strains were produced in the pipe. After the pipe was about two-thirds submerged, rafts (made of oil barrels) having a floating power of 5,000 pounds each were attached to the ends of the pipe section. The attachments were made near the top of the pipe, in order to keep it while floating in the same position as while being built. When the pipe and rafts had been submerged until the top of the pipe was about 1 foot above the surface of the water, it floated from the cradle. The pipe was then pulled out of the cradle and was ready for towing. As soon as the pipe was drawn out the engine was reversed and the cradle was lifted to its position, ready to commence a new pipe. About one and one-half hours were consumed in lowering and removing a pipe from the cradle, and about twenty minutes were necessary to raise the cradle into position ready for making a new pipe. A tow-boat was used to take the pipe to the trench prepared for it. The dates of launching and laying pipes were: July 7, 17, 28; August 5, 9, 15, 18, 22, 27, 30; September 7, 8, 15, 18, 22, 26.

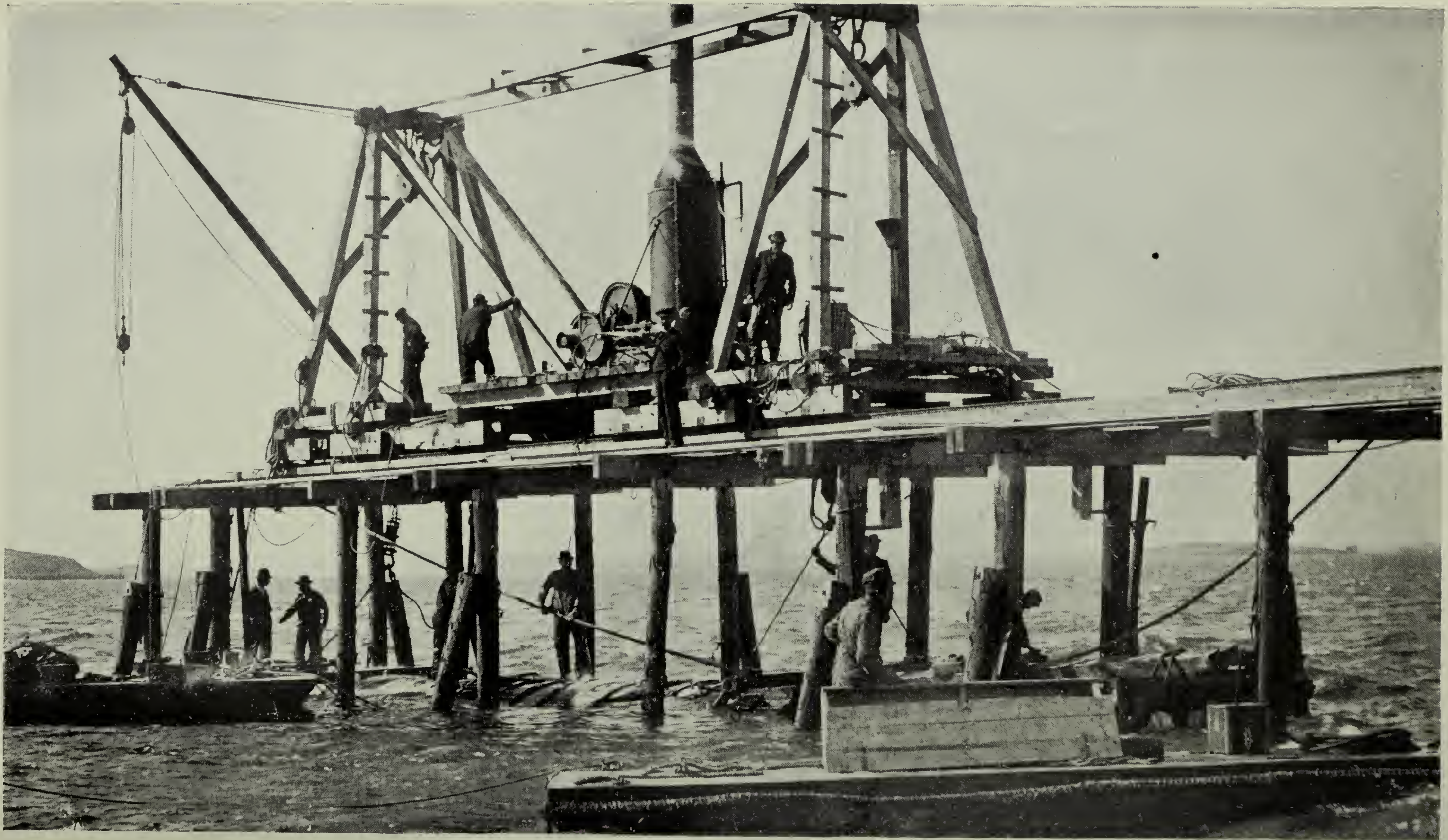
Lowering Pipes into Position at the Outfall. — This was done by a system of travelling shears running on the temporary pilework. The apparatus is clearly illustrated by photograph and drawings. To control the pipe while being lowered, and to insure its proper placing, vertical guides (previously described) were used to prevent lateral movement, and check ropes to prevent endwise movement were used. Each pipe was lowered about 6 inches from the end of the section previously laid. To bring the pipe back against the previous section, a windlass was placed about 50 feet back, from which a rope led to the pipe. Tell-tales were rigged so as to show if the pipe varied from a horizontal position as it went down. Everything being ready, the diver opened the two 2 inch holes in the end of the pipe by driving the pine plugs inward. At the same time the 1 inch test pipe at the top of the section was opened to allow air to escape. In about four minutes the pipe had received water enough to sink it, and the diver plugged the 2 inch holes, this time from the outside. The small



Section 1, Deer Island. Pipe Section lowered in Cradle, ready for Launching.



Section 1, Deer Island. Towing One of the Pipe Sections from the Cradle to the Outfall.



Section 1, Deer Island. Getting Pipe Section into Place under Travelling Shears, for lowering into Place.

test pipe was also closed. To insure that the pipe was kept level during lowering (which was necessary, to prevent the water on the inside from running to one end), the drums of the double hoisting engine were wound until each was of the same size as the other. Then the engine was allowed to back down with frictions set up. Since the drums were of the same size, and they were geared together, both must turn alike. Just before the pipes rested on the sills, the winch behind was used to pull the pipe section back to the preceding one; after which the pipe was adjusted exactly to line and grade. The pipe section was then bolted to the preceding section by 40 hook-bolts. The thread end of each bolt passed through a hole in a right-angled steel hoop near the outer end of the pipe section previously laid. The hook end passed over one edge of an oblique-angled steel hoop near the inner end of the newly laid pipe section. Common bolts and two right-angled steel hoops might have been used. In this case, the newly laid pipe would have had to be revolved until the holes in one hoop came opposite those in the other. The joint between the two pipes was made perfectly tight by means of the rubber gasket. After the pipe was precisely placed and bolted, a wire rope was placed about the forward end and attached to the piles, to prevent any movement of the end by the tidal current or waves. Back-filling of earth over the pipes was kept to within about 1½ lengths of the newly laid pipe. At Station 12 a special man-hole pipe was laid. A suction for a 6 inch centrifugal pump and a 4 inch pipe for admitting air have been provided in this bulkhead, to use, if necessary, during work on interior of the pipes.

Completion of Interior of Pipes. — As fast as the pipes are laid and back-filled the end bulkheads are removed, the water used in sinking pumped out and the masonry completed. Several pipes, however, intervene between the outermost one and that in which bulkheads are being removed. But one joint, thus far, has been found to leak, and that no more than would come through a 1-16 inch hole with 25 feet head. The leak was easily stopped.

All material is removed from and brought into the sewer by means of a man-hole on shore at about Station 0.

Light is furnished for work inside the sections by a Westinghouse dynamo.

The outlet sewer will probably be completed to its outer end, 1,860 feet from the Deer Island shore, before Christmas.

During the period of 114 days (from beginning of work on trench June 9 to September 30) 900 feet of trench had been prepared and pipe laid therein, giving average daily rate of 8 feet (nearly). During September seven pipes (364 feet) were finished ready to lay, but a storm September 30 delayed the laying of the last one until beyond limit of this period.

PUMPING STATION AND CONNECTIONS (DAY WORK), DEER ISLAND.

Location. — On the south-westerly side and about midway of Deer Island.

Length of section, about	340 feet.
From 9 foot circular sewer built in 1891 to site of pumping station,	90 "
Pumping station { width,	35 "
Pumping station { length,	168 "
Site of pumping station to 6 foot by 10 foot sewer built in 1891,	45 "

State Assistants.

Assistant Engineer to February 12: Laurence Bradford.
Assistant Engineer since February 12: Frank E. Winsor.
Foreman: Charles G. Craib.
Sub-foreman: John Craib.
Transitmen: Principal, to Jan. 21, 1894 — Nathan B. Wilber.
" Principal — George A. Winsor.
" Assistant — John T. P. Jones.

Screen Man-hole.

Just below end of 9 foot circular sewer built in 1891.
Length, including connection with sewer above, 17 feet.
All masonry laid in Portland cement mortar.

Incoming Sewer.

Size, 10 feet 8 inches by 8 feet. Length of closure built this year, 123 feet.
About three-quarters of the excavation (tunnel) was in stiff blue clay, the remainder near the open cut was hard-pan with clay at the bottom.
All masonry laid in American cement mortar.
Excavation begun about March 1, 1894.

Increaser.

Connects incoming sewer with suction conduit. Size increases from 10 feet 8 inches by 8 feet to 13 feet by 8 feet. Length, 10 feet.

Suction Conduit.

Located just outside of and parallel with the pumping station building.
Size, 13 feet by 8 feet. Length, 73 feet.
Average depth of excavation, 29 feet.
Average width at top of trench, 15 feet.
Average width at bottom of trench, 14 feet.
The material excavated was coarse gravel and sand with hard-pan at the bottom, below which, on the upper end of the trench, stiff blue clay was found.
Portland cement mortar used in the concrete arch; American in the rest of the structure.

Three Circular Pump-wells, with Inlet and Outlet Channels.

Diameter of excavation,	24 feet.
Depth of excavation,	35 "

Character of Excavated Material. — In wells 1 and 2, hard-pan in the upper part and stiff blue clay in the bottom. In well 3, coarse gravel with some sand until near the bottom, then hard-pan.

A trench machine was used.

Work begun Nov. 2, 1893. Completed about December 30.

Masonry.

For wells 1 and 2: —

Floor consists of brickwork 8 inches thick, resting upon concrete 2 feet 4 inches thick.

Sub-well, from elevation 85.5 to 92.0, internal diameter 8 feet. Side walls consist of brickwork 8 inches thick and concrete backing 7 feet thick.

Main well, from elevation 92 to elevation 117, internal diameter 16 feet. Side walls consist of brickwork 8 inches thick and concrete backing 3 feet 4 inches thick. American cement used up to elevation 110; Portland cement above this. Begun the latter part of December, 1893. Completed March 12, 1894.

For well 3: —

Floor of concrete, 2 feet 4 inches thick.

Side walls of concrete, 2 feet thick.

Internal diameter, 20 feet.

Depth, 32 feet.

Portland cement used entirely, except about 2 feet at the bottom.

Begun latter part of December, 1893. Completed March 8, 1894.

Discharge Sewer.

Size, 6 feet by 10 feet. Length of closure built this year, 124 feet.

Average depth of excavation, 18.5 feet.

Average width of trench, 12 feet.

The material excavated was mostly coarse gravel and hard-pan.

A single boom derrick with steam hoister was used in excavating, and the material was removed by carts.

Work begun about Feb. 1, 1894.

An 8 foot 4 inch circular branch, 21 feet long, leads from discharge sewer, for possible future reservoir connection.

Total Quantities and Cost.

	Cubic Yards.	Cost per Cubic Yard.
Excavation,	5,300	
Brickwork, American cement mortar,	500	$13 65
Brickwork, Portland cement mortar,	270	15 70
Concrete, American cement mortar,	585	4 60
Concrete, Portland cement mortar,	1,130	6 60

Total cost of day work, including pump-wells, building foundations, connecting sewers, etc., ... $44,100

But little water was encountered in the first two wells; that in the first one being handled by a 1 inch steam ejector and in the second by a 4 inch pulsometer.

In the third well some difficulty was experienced from the sea-water at high tide, and occasionally operations were suspended in consequence. A 4 inch pulsometer sufficed here. The sheeting of the wells consisted of 1 inch poling boards, 3 feet 2 inches long, held in place by spruce ribs made by bending half inch boards and nailing them one upon the other until a thickness of 6 inches was obtained. For the last 43 feet of the discharge sewer pumping was necessary, which was done by a 6 inch centrifugal pump. The maximum amount of water pumped in twenty-four hours was about 290,000 gallons.

Excavation for the incoming sewer was done by tunnel. For the suction conduit the excavation was by open cut. A trench machine was used. The only pumping done was by a 2 inch steam ejector in the lower end of the open cut.

Wheel Casing Foundation. — In the perimeter of the sub-wells were set two circles of heavy granite cut stone 14 inches thick bedded in the concrete. The bottom of one circle was one foot above the floor of the well, and the top of the other circle was even with the top of the well. These stones form the foundation for the wheel casing, which is held in place by eight anchor bolts passing through both circles of stone.

Main Frame Foundation. — Granite blocks were set in the perimeter of the main wells, 7 feet below floor level, and corresponding stones at the floor level, to which the main frame is bolted.

Cylinder and Air Pump Foundation. — Seven feet below the floor level, around pump-wells 1 and 2, granite blocks were imbedded in concrete, and similar blocks were laid at the floor level. Sixteen anchor bolts pass through each foundation. The top stones were set and the engine foundations completed March 12.

Sub-foundations. — Sub-foundations for the building were put in up to grade 111.75, as follows: 90 linear feet of concrete foundation for the west walls of engine and boiler house was built up from the haunch of the suction channel; work completed April 25. Under the remaining west wall of the boiler house concrete from 8 inches to 2 feet 6 inches thick was placed; work completed May 5. Under the remaining west wall and entire south wall of engine house a concrete foundation from 2 feet to 6 feet in thickness was placed; work completed May 26. From the haunch of the discharge sewer 84 linear feet of concrete foundation was brought up for a part of the east wall of the engine house; work completed April 5. The remaining foundations of the building rest on hard-pan at grade 111.75. Chimney foundations rest on hard-pan at grade 110.50.

Temporary Building. — To facilitate work during the winter, a temporary building 114 feet long and 36 feet wide was erected over the three pump-wells.

PUMPING STATION (CONTRACT WORK), DEER ISLAND.

Structures. — A building of brick, granite and terra-cotta, containing an engine-room 100 feet by 31½ feet, inside measurements, and 15 feet high to bottom of roof trusses; a boiler room 63 feet by 35 feet and 17 feet high to bottom of roof trusses, and additional space for toilet rooms, economizer, etc. Chimney 125 feet high. The station will contain two pumping engines, boilers, etc., described in last year's report. Both the building and pumping plant are being done by contract.

State Assistants.

Architect: Arthur F. Gray.
Assistant Engineer: Frank E. Winsor.
Inspector of masonry: Caleb Kimball.
Transitmen: Principal — George A. Winsor.
" Assistant — John T. P. Jones.

Contractors.

Contractors for pumping station: Gooch & Pray, Boston, Mass.
Contractors' superintendent and principal foreman to June 7: James S. Grant.
Same since June 7: Charles F. Marr.
Contractors for pumping plant: The Edward P. Allis Company, Milwaukee, Wis.
Contractors' superintendent and principal foreman: Forrest E. Bingham.

Excavation for building foundation began April 23. The first foundation stone was set May 1. All stone masonry was completed June 29. The footing course of all foundations, except that of the chimney, is about 4½ feet below the surface of the ground. The bottom of the chimney foundation is 6 feet below the surface. The boiler-house walls are, in part, over the incoming sewer, which, as stated under the heading of "Day Work," was built by tunnel, and in order to prevent any possible settlement, pipes were driven down every 6 feet to the top of the arch and cement grout was forced through, thus filling any void spaces which might exist. Brick masonry on the boiler house and chimney was begun May 21. The chimney was completed July 20 and the cap set July 30. Masonry on the walls of the building, up to the bottom of the roof trusses, was completed July 13. After this a long delay occurred on account of the roof trusses. The first ones shipped were rejected, on account of being scant in dimension as well as rough and distorted. August 14 work was again begun, and even then the progress was slow. September 17 the engine-house roof was ready for the carpenters, and the iron work on the remainder of the building is now complete, except a few minor details. The completion of the roof, floors, doors and windows and the painting and plumbing still (September 30) remain to be done under the present contract.

Pumping Plant. — The first lot of machinery for the pumping plant arrived at Deer Island June 15, and most of the remainder

September 5. Considerable progress has been made in setting up the plant. The gates in the suction channels and the check valves in the discharge channels have been set. The wheel casing, wheels, main shafts and main frames are all in position but not levelled up; the cylinders and air pumps have been placed on their foundations but are not accurately in place.

SECTION 3½ (DAY WORK), SIPHON, SHIRLEY GUT.

Location. — From the end of Section 3 (already built), on the northerly end of Deer Island, under Shirley Gut to the beginning of Section 4 (already built), on the southerly end of Point Shirley, Winthrop.

Length of section, about	430 feet.

NOTE. — In the report for the year ending Sept. 30, 1893 (the fifth annual report), a description was given of damming Shirley Gut, dredging a trench across the bed of the Gut and laying therein a single line of brick-lined steel siphon pipe, in four sections. The cost of all this work to Sept. 30, 1893, was about $33,000. The operations for the year ending Sept. 30, 1894, are described below.

Character of Masonry Structures built during Year ending Sept. 30, 1894.

Deer Island side: —	
9 foot brick sewer, with 6 foot 4 inch branch and gate chamber, length,	74 feet.
Reducer to 6 foot 4 inch brick sewer, length, ...	11 "
Siphon: —	
Two man-hole sections * (straight lengths at either end of siphon, with a temporary man-hole going above high water), length, each, . .	12 "
Point Shirley side: —	
6 foot 4 inch brick sewer, length, ...	28 "
Gate chamber and connection with sand-catcher, length, ...	10 "
Sand-catcher (16 feet by 16 feet, with 6 foot 4 inch branch), length, .	28 "
Reducer to sand-catcher, length, ...	5 "
9 foot brick sewer, length, ...	11 "

State Assistants.

Assistant Engineer (to February 12): Laurence Bradford.
Assistant Engineer (since February 12): Frank E. Winsor.
Foreman: Charles G. Craib.
Engineering Clerk: Frederick D. Smith.
Transitmen: Assistants — George A. Winsor, Nathan B. Wilber, Daniel J. Sullivan, John T. P. Jones.
Laurence Bradford, assisted by Daniel J. Sullivan, also had charge of removal of bulkhead dam. Frank I. Capen had charge of final lining of pipe siphon.

Principal Furnishers of Labor.

Back-filling siphon trench and dredging to restore bed of Shirley Gut to its natural condition: Perkins & White.
Removing pile bulkhead: William Miller.

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* Built last year, but placed this year.

Trench and Masonry.

	Deer Island Connection.	Winthrop Connection.
Total excavation, cubic yards,	1,130	1,340
Total brickwork, cubic yards,	111	136
Total concrete, cubic yards,	185	303
Cost of brickwork, per cubic yard,	$15 75	$14 31
Cost of concrete, per cubic yard,	$5 67	$6 49
Brickwork begun,	Jan. 31, 1894.	May 24, 1894.
Brickwork finished,	March 22, 1894.	June 10, 1894.
Concrete begun,	Jan. 26, 1894.	May 11, 1894.
Concrete finished,	March 1, 1894.	July 5, 1894.
Character of earth excavation,	Sand and gravel.	Sand and gravel.

Portland cement mortar was used for all the masonry.

Approximate total cost of section from the beginning of work in 1893 to date (Sept. 30, 1894): —

Deer Island connection, including gate chamber, branch, reducer, etc.,	$9,492	
Masonry siphon with steel shell, including final lining,	26,890	
Winthrop connection, including gate chamber, sand-catcher, branch, etc.,	9,660	
Dam-work, dredging, back-filling, etc. (in Shirley Gut),	16,100	
Total,		$62,100

Underdrain.

SIDE.	Size (Inches).	Length (Feet).	Elevation of Bottom.
Deer Island,	15	85	9.5 feet below low water.
Deer Island,	12	20	
Point Shirley,	15	120	8.3 feet to 10 feet below low water.
Point Shirley,	10	22	

Pipe Work. — About the middle of October, 1893, the two man-hole sections of the siphon (steel shells lined with masonry) were launched, floated into place and connected with the main portion of the siphon respectively on the Deer Island and the Winthrop end. As soon as practicable thereafter the temporary top of each man-hole going above high water was bolted on. Pumping water from the siphon was then begun, followed by removing the wooden bulkheads in the pipe and making the masonry lining continuous. The last bulkhead was removed about the middle of November. The pipe was found to be practically without leakage. In the meantime back-filling over the pipes had been continued, and the flange joints had been covered with clay brought in scows. The siphon was lined very smoothly with Portland cement mortar rammed into place. Elm hoop furrings soaked in hot paraffine and fastened with heavy copper rivets were used. This work of lining the siphon occupied from the first of May to the middle of June.

Excavation, Deer Island Side. — Work here began October 29. The first step was to drive 4 inch sheeting around the entire extent of the proposed trench, and securely brace it down to low-water line. Filling was dumped around the outside of the sheeting. This filling was in part carted from the site of the Deer Island pumping station, as the material at hand was too porous to exclude water. A double incline was used in excavating. The water encountered was principally leakage from the sea, although at the time connection was made with Section 3 a large proportion of the water came from the underdrain of that section. The following plant was used in removing the water: beginning with a 9 inch Andrews centrifugal pump, run by a 25 horse-power Hoadley engine, a 6 inch pump of the same type was added February 3, and still another February 20. Excavation was finished Feb. 19, 1894.

Excavation, Winthrop Side. — Work here began March 13. The general plan of the sheeting was the same as on the Deer Island side. The same incline and pumping equipment was used here as on the Deer Island side. The water encountered was leakage from the sea, and a large amount from the underdrain of Section 4. Excavation was finished June 7, 1894.

Miscellaneous. — The dredging to restore the bed of Shirley Gut to its natural condition was done in the spring of 1894. The pile bulkhead across Shirley Gut was removed in May and June, 1894.

Section 7, Winthrop and East Boston.

Location. — From a point about 300 feet westerly from Pleasant Street station, on the Boston, Winthrop & Shore Railroad, across Belle Isle Inlet and Marsh Island to a point on the marsh in East Boston about 100 feet easterly from Riverside Avenue.

Contractors. — Trumbull & Ryan of Boston, Mass.

Contractors' Superintendent and Principal Foreman (Year ending Sept. 30, 1894). — Charles E. Trumbull.

State Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Henry H. Marden, Jr.
Superintendent of construction (from July 21): Charles G. Craib.
Inspector to July 21 and then Engineering Clerk: R. H. Sumner.

The main sewer, sand-catcher and overflow were built without special difficulty. All of this construction, except for a portion of the main sewer, was prior to this year and was described in previous reports. In building the descending part of the siphon on the East Boston side, and the lowest part of the siphon directly beyond, great difficulties were experienced from floodings of the trench. The following quotation from the fifth annual report, concerning the coffer-dam, explains how these difficulties arose : —

> The fineness of the sand forming the bed of the inlet was such that it gave great resistance to penetration by sheet piling. After the plank had been driven about 5 feet into the sand, the blow from a hammer 2,200 pounds weight, falling twenty feet, would cause a penetration of one-quarter of an inch. . . . The effect of the hard driving was seen as trench excavation progressed. Some planks projected into the trench, and some out. The grooves were opened in a majority of cases. At high tide sand and water came in through these cracks freely.

At the beginning of the present year the following work remained to be done : —

	Excavation, Linear Feet.	Masonry, Linear Feet.
Main sewer, ...	3.00	138.52
Lower part of siphon, ...	94.00	94.00
Rise from siphon (Winthrop side), ...	26.20	26.20
Pipe chamber, ...	7.00	7.00
Reducer from pipe chamber to main sewer, . . .	8.00	8.00

The first work during the year just ended (September 30) was to finish the masonry of the main sewer on the Winthrop side of Belle Isle Inlet. In proceeding with the siphon work similar difficulties were encountered as previously, and others in addition. There remained a gap of about 79 feet of coffer-dam on the Winthrop side to close up. The contractors started to close this, and at the same time to remove a portion of the coffer-dam around the completed work on the East Boston side. The closing of the gap was made directly at right angles to the current, and produced at that point a very rapid flow. This scoured the bed of the inlet at the point of closure down to a depth about 21 feet below mean low water, or about 18 feet below the original surface of the bed of the inlet. The scour undermined the end of the main sewer on the Winthrop side, causing the sewer to crack at a point 40 feet back from the end of the siphon. This short piece of sewer, which rested on piles, then moved slowly toward the siphon for a distance of 1.8 feet. The moving piece of sewer was then secured to the solid work behind, and thereafter no further movement occurred. The outer end settled about 3½ inches.

One side of the sheeting for the coffer-dam at the closure oscillated with the tide. The oscillation was stopped by driving spur-shores, after which the other side of the coffer-dam was completed, and the dam made tight by filling outside up to low water. The siphon and part of the rise from the siphon were then built inside of this coffer-dam. Work stopped at this point June 4.

The work of making a connection between the portion of the masonry siphon constructed in the old coffer-dam and that constructed in the new one was begun June 5. This place was not far from the middle of the stream. The contractors, however, did not succeed in pumping out the coffer-dams at this place, and so were unable to make any progress in connecting. The contractors had used more than double the time that was called for in the contract; but, as they had had a good previous reputation, much experience on this kind of work, and were desirous of completing the job, they had been allowed to continue.

During the two years and more the contractors had been engaged on this section, other difficult work, such as siphons, engine foundations, the outfall sewer, etc., had been nearly completed, and it was felt that prudence required that Section 7 should no longer be left to the uncertainties of a contractor's operations, but should be taken by the State and prosecuted directly. It was accordingly taken from them July 21.

As the first step in the Board's work, July 30, an attempt was made to pump down the water in the trench near the middle of the siphon, where the contractors had attempted to do so and failed. By the use of two 6 inch centrifugal pumps which they had previously used, and an additional 9 inch pump, the water in the trench was pumped down to within about 3 feet of the bottom of the siphon. Several heavy leaks were found, where water boiled up, bringing sand with it. The quantity of sand which boiled into the trench was so great as to show that some other method of precedure was necessary. At this place it was now necessary to excavate sand in the bottom of the trench for a depth of about 3 feet. As it was impracticable to pump out the water without building a new dam, and as it was not thought best to build the latter, an attempt was made to excavate the sand by pumping it. This was done to some extent; but with the apparatus in hand and the conditions that here obtained, the work proceeded very slowly, and it was supplemented by the operations of divers. The trench by these methods was excavated to a depth of 1.83 feet below the water line of the sewer. Steel rails weighing 60 pounds to the yard were then placed across the trench about 8 inches above the bottom and about 1 foot apart. Portland cement grout was next deposited in the trench to the level of the water line, completely surrounding these rails. Forms were then set on the sides, and a wall of masonry of the same kind of grout was formed against the sheeting. Each of these walls was 6 feet high and averaged 12 inches in thickness. The grout was poured through wooden tubes which extended from the top of the trench to the bottom of the water. This work was finished September 25. After the grout has had eight days to set, the trench will again be pumped out and the closure of the masonry completed.

PUMPING STATION (DAY WORK), EAST BOSTON.

Location. — On northerly side of Addison Street, about 300 feet from corner of Chelsea and Addison streets, on south side of Chelsea Creek, east of and adjacent to Grand Junction Railroad location. The area covered by stations and connections is 210 feet long and 75 feet wide.

State Assistants.

Assistant Engineer: Henry H. Marden, Jr.
Transitmen: Principals — Charles L. Weeks, Charles Kincaid.
" Assistants — F. M. Wilbar, J. J. Comfrey.
Principal Foremen: John Collaran, B. L. Sykes.
Sub-foremen: John Cain, Daniel Hogan.

The day work comprises connections with sections 9 and 10, screen chamber, suction conduit, pump-wells, discharge channels, boiler foundations, sea wall along the creek, chimney foundations, and foundations for the building where deeper than elevation 112.

Work began Nov. 8, 1893, and was finished May 21, 1894, with the exception of the screen chamber. The screen chamber is unfinished, the top and guides remaining to be done.

Screen Man-hole and Chamber. — The screen chamber is a complicated structure designed to receive the sewage from Section 10 and the East Boston branches before it enters the suction conduit. Its foundation is 52 feet deep.

Total cost, including excavation, masonry, pumping, etc., ...	$8,100

The suction conduit extends along the southerly side of the engine house, a distance of about 110 feet. The inside dimensions are 10 feet by 13 feet 6 inches for most of its length. For a length of about 60 feet, this was built by tunnelling, but as it was directly under the south wall of the building and there was doubt about it being possible to back-fill thoroughly enough to prevent some settlement of the surface, the last 50 feet was built by open cut. The depth was about 40 feet below street surface to under side of masonry.

Total cost, including excavation, masonry, pumping, etc., ...	$10,150

Pump-wells, including Foundations for Pumps and Engines.— The three pump-wells are each 24 feet diameter outside of masonry and 41 feet deep to under side of masonry. In excavating them a trench machine was used, so arranged that the tubs could be lowered into the three pits at one time. The material of excavation was composed of clay and stones, hard to dig, but liable to flake off on exposure to the air. In pits 2 and 3 a stratum of soft material, encountered about half-way down, caused a slip in the sides, and a delay of about a week. When the masonry was built into the pits all sheeting and bracing were taken out and the masonry built against the earth.

Total Cost of Pump-wells.

Excavation,	$3,600
Concrete,	7,000
Brickwork,	4,750
Stone-work,	2,150
Pumping,	500
Miscellaneous,	3,000
Total,	$21,000

Discharge Channels and Connection with Section 9.— These comprise three channels, each 4 feet in diameter and 45 feet long, a piece of sewer 9 feet in diameter, 30 feet long, and a reducer 9 feet to 4′ feet, 25 feet long. Each discharge in a distance of 21 feet from pit rises by reversed curves 14 feet vertically.

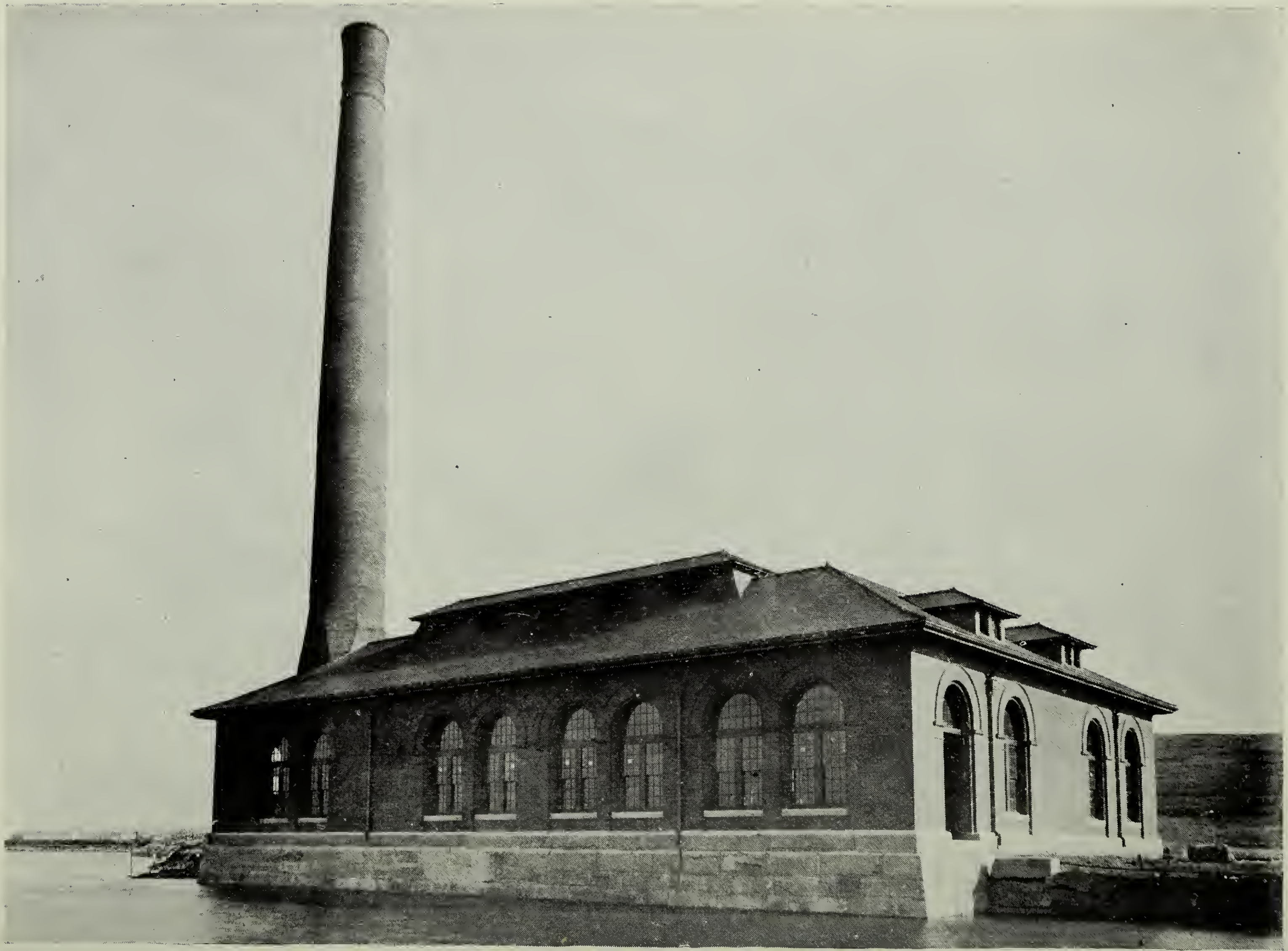
Total cost of discharge channels and connections with Section 9, including excavation, masonry, etc., ... $7,400

Sea Wall.— This extends along the creek and under ends of boiler house, a length of about 165 feet. It is 10 feet wide on base and 4 feet on top, having a face batter 1 in 8. The top is 16 feet above low water. The wall was composed of a face of split granite, backed up by Portland cement concrete.

Total cost of the sea wall, including excavation, masonry, pumping, etc., $4,050

Foundation Walls of Engine and Boiler House.— Where ground had been disturbed by other operations, or natural conditions required a foundation to be put, extending lower than elevation 112, walls of concrete 42 inches thick were built to a good foundation.

Total cost, including excavation and masonry, ... $2,775



Pumping Station (unfinished), East Boston. View from Grand Junction Railroad Bridge over Chelsea River.

Chimney Foundation. — This was built of split granite, laid in courses. The foundation was 20 feet square at low water, 16 feet square at bottom of brickwork, and is 16 feet high. Before laying any stone the surface of the ground was compacted by dropping on it from a height of about 3 feet a pile hammer weighing 1,800 pounds. After going over the surface thoroughly this way, a layer of concrete 6 inches thick, mixed with very little water, was rammed in same manner. On this foundation the stone-work was started.

Total cost, including excavation, masonry, pumping, etc., ...	$2,500

Foundations for six boilers are placed. They consist of concrete blocks on which brickwork rests, and are in part 8 feet thick.

Total cost, including excavation, masonry, etc., ...	$2,150

PUMPING STATION (CONTRACT WORK), EAST BOSTON.

Structures. — A building of brick, granite and terra-cotta, containing an engine room 100 feet by 31½ feet, and boiler room 100 feet by 31½ feet including toilet and tool rooms, economizer, etc. A chimney 125 feet high, with 4 feet 6 inches flue.

The station will contain two pumping engines, boilers, etc., described in last year's report.

State Assistants.

Architect: Arthur F. Gray.
Assistant Engineer: Henry H. Marden, Jr.
Transitmen: Principals — Charles L. Weeks, Charles Kincaid.
" Assistant — J. J. Comfrey.
Inspector of building: James E. Coyne.

Contractors.

Contractor for pumping station building. — E. E. Strout, Lynn, Mass.
Contractor's Superintendent. — Jacob Moulton.
Contractors for pumping plant. — The Edward P. Allis Company, Milwaukee, Wis.
Contractors' Superintendent. — Forrest E. Bingham.

Machinery. — The work of erecting the machinery began in May, 1894, and has proceeded slowly since. The same outfit which was erecting machinery here was also used in erecting the machinery at Deer Island, and when working at one place operations at the other were suspended. September 30 the two pumps were in place and considerable work done on the engines.

Building. — The contractor began work May 19, 1894. September 30, chimney was completed and all walls of the building and roof completed. There yet remains to be done some work on the plumbing and toilet rooms, and the floors are to be put in; also some miscellaneous small items of finish.

SECTION 10 (DAY WORK), EAST BOSTON AND CHELSEA.

Location. — From pumping station at East Boston, near the Grand Junction Railroad bridge over Chelsea Creek, thence under Chelsea Creek, between the Grand Junction Railroad bridge and the Chelsea Street road bridge to a point on Marginal Street, near Eastern Avenue, in Chelsea, where connection is made with Section 12.

Length of section,	708.67 feet.
of siphon (tunnel),	504.00 "
of gate chamber and overflow,	38.00 "
of sand-catcher,	145.00 "
of reducer to main sewer,	10.00 "
of main sewer (9 feet diameter),	11.67 "

Assistants.

Assistant Engineer: Henry H. Marden, Jr.
Transitmen: Principals — Charles L. Weeks, Charles Kincaid.
" Assistant — J. J. Comfrey.
Draughtsman: F. M. Wilbar.

Tunnel (from Beginning of Work in 1892).

Excavation.

Length excavated,	504 00 feet.
Average depth from surface of ground to bottom of excavation,	53.00 "
Greatest depth from surface to bottom of excavation,	58 20 "
Average width of excavation,	8.00 "
Volume of excavation per linear foot,	2.00 cu. yds.

Masonry.

Length completed,	504.00 feet.

Masonry begun Nov. 15, 1892; finished May 4, 1893.

Total cost of tunnel, including shafts, bracing, excavation, masonry, pile foundation, repairs, pumping plant, superintendence and miscellaneous items, $16,550.

Sand-catcher, Overflow and Gate Chamber (from Beginning of Work in 1892).

Trench.

Length excavated to bottom of pile caps,	204.67 feet.
Average depth to bottom of pile caps,	23.00 "
Greatest depth to bottom of pile caps,	29.00 "
Average width, top of trench,	32.00 "
Average width, bottom of trench,	29.00 "
Volume of excavation per linear foot,	26.00 cu. yds.

Masonry.

Length completed,	204.67 feet.

Masonry begun Dec. 6, 1892; finished March 23, 1894.

Total cost of sand-catcher, overflow, gate chamber, reducer, branch, etc., including excavation, sheeting and bracing, coffer-dam, masonry, pile foundation, pumping, grading and miscellaneous items, $64,000.

Excavation for Year ending Sept. 30, 1894.

	Sand-catcher.
Character of opening,	Open cut.
Date of starting,	Oct. 1, 1893.
Point of beginning or continuing from last year's work,	Station 6 + 55.
Point of ending,	Section 12.
Date of finishing,	March 5, 1894.
Gang ordinarily employed,	50 men.

Pumps, etc. — Ordinarily a No. 5 pulsometer pump handled the water, though at times two 6 inch centrifugal pumps were required. Estimated greatest rate of pumping in twenty-four hours, 1,700,000 gallons. In addition to the above, one pump (Blake, 8 inches by 12 inches by 14 inches) was kept running to keep down the water in from 12 to 24 wells, each 56 feet deep. These wells were of the same kind and for the same purpose as those described in the fifth annual report, page 43.

The foundation was on piles, as described in last year's report.

Repairs. — Soon after driving piles for the foundation of the dry wall which extends from the corner of the gate chamber to the bridge abutment, a crack was noticed in the roof of the rise from the siphon. Apparently driving the piles had cracked the structure, and the sand entering had undermined it, causing it to settle. It was decided to remove the rise and rebuild it. For this purpose a shaft was sunk around the rise, using 6 inch sheeting driven by a water jet to a depth 2 feet below the masonry. Inside the shaft 12 wells were driven, and a pump connected with them low enough to thoroughly drain the sand underlying the sewer. The old work was removed and piles driven at random about 2 feet 6 inches apart in the bottom. Concrete was placed around the piles, and on this foundation the rise was built.

Later investigations showed that the adjoining siphon had become distorted by the operations, and to repair this an air-lock was placed in the shaft, a bulkhead built in the siphon back about 200 feet, and compressed air used. For a distance of 25 feet from bottom of the rise the old work was taken out entirely. From 25 to 88 feet back from the bottom of the rise various parts of the arch and invert were taken out and replaced. The sewer in this locality has been examined at frequent intervals for a period of several months. No further indications of injury of any sort have been found.

SECTION 11, CHELSEA.

Location. — From Marginal Street, Chelsea, through Eastern Avenue to near Willoughby Street, crossing under the Boston & Albany Railroad (Grand Junction) and Bass Creek.

Length of section,	3,030 feet.

Diameters of sewer, 2 feet 1 inch by 2 feet 10 inches.

Contractor. — Charles Linehan of Cambridge, Mass. Mr. Linehan has acted as his own superintendent.

State Assistants.

Assistant Engineer and Inspector: Francis L. Sellew.
Transitman: W. Gordon Crispin.

Trench.

Length completed,	2,003.00 feet.
Average depth of excavation to bottom of pile cap,	17.00 "
Greatest depth of excavation to bottom of brickwork,	18.35 "
Average width, top of trench,	6.10 "
Average width, bottom of trench,	4.20 "
Volume of excavation per linear foot,	3.25 cu. yds.

Approximate cost of trench per linear foot, including sheeting left in, excavation and back-filling, etc., $3.45.

Character of Excavation. — At lower end of section: 1 foot of gravel and ashes, 1 foot of filling (ashes, etc.), 2½ feet gravel and clay, 7½ feet of fibrous peat, with silty sand below. This formation extends for 1,018 feet, to near Cottage Street. For 200 feet northerly from Cottage Street: 1 foot of gravel and ashes, 2 feet of filling (ashes, etc.), underlaid by hard yellow clay to bottom of trench. Next 400 feet: 1½ feet of gravel and ashes, 10 feet of yellow hard-pan, blue hard-pan below. Bass Creek to present end of trench, a distance of about 400 feet: 1½ feet of gravel and ashes, 1½ feet filling (ashes, etc.), 7 feet of peat, silty sand below. The silty sand mentioned in this paragraph was so fine that 81 per cent. passed through a sieve having 14,400 meshes to the square inch, and 20 per cent. through one having 32,400 meshes to the square inch.

Masonry.

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$13 00
Brickwork, Portland cement mortar, per cubic yard,	16 00
Concrete, American cement mortar, per cubic yard,	4 50
Concrete, Portland cement mortar, per cubic yard,	6 00

Length completed,	1,700 feet.
Diameters of underdrain laid and length of each size: —	
6 inch,	295 "
8 inch,	279 "

Masonry was begun June 20, 1894, and is now (September 30) in progress.

Approximate cost of masonry per linear foot of trench, including piles, underdrain, etc., $5 20.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection, etc., to date (September 30), $8.90.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening.	Open cut, . . .	Open cut, . . .	Open cut.
Date of starting, .	May 22, 1894, . .	May 30, 1894, . .	Aug. 29, 1894.
Point of beginning, .	Central Avenue, .	About 80 feet north of Boston & Albany Railroad.	Central Avenue.
Point of ending, .	About 80 feet north of Boston & Albany Railroad at opening No. 2.	In progress about 439 feet north of Bass Creek.	In progress about 70 feet north of Marginal Street.
Finished or in progress September 30.	Finished Sept. 6, 1894,	In progress, . .	In progress.
Length, . . .	318 feet, . . .	1,493, exclusive of 87 feet, left at Bass Creek to be done later.	192 feet.
Ordinary progress per week.	40 feet, . . .	80 feet, . . .	40 feet.
Appliances used, .	Derrick, . . .	Trench machine, .	Derrick.
Gang ordinarily employed in excavation.	15 men, . . .	20 men, . . .	15 men.

A 4 inch centrifugal pump was used at Central Avenue, and another about 80 feet north of the Boston & Albany Railroad. These, together with hand pumps at various places, took care of all the water.

Foundation. — The bottom of the trench was yellow hard-pan for a distance of about 527 feet from about 87 feet north of Cottage Street to near Bass Creek, and was excavated to fit the bottom of the sewer. From about 70 feet north of Marginal Street to Cottage Street, a distance of about 948 feet, and from Bass Creek north to the present end of the trench, a distance of about 439 feet, the bottom was composed of fine, silty sand. The sewer was in this place built on a pile foundation. Piles averaging 10 inches in diameter were driven in bents of two. The tops of the piles were covered by 8 inch by 10 inch spruce caps, on which a 3 inch spruce platform was laid. The piles were from 11 feet to 30 feet in length, but were mostly from 20 feet to 25 feet. For about 87 feet in a northerly direction from Cottage Street the bottom of the trench was yellow clay. The trench was made with a square bottom. Concrete was here placed in the bottom of the trench, and brought up to fit the 4 inch brick invert of the sewer.

Miscellaneous. — The sewer was built under the Boston & Albany Railroad. Here the masonry was laid in Portland cement, and the arch was covered with 6 inches of concrete. The sewer was built under a culvert situated about 75 feet south of Central Avenue. The sewer was built under another culvert, about 225 feet north of the Boston & Albany Railroad. Here a concrete pier was built to support the culvert.

About 75 feet south of Central Avenue the trench moved toward the west after the piles had been driven. As making the trench here was a matter of some difficulty, a slight change was made in the alignment of the sewer, to admit of building in the trench in the position it had taken.

The surplus earth gained by the sewer operations was left by the contractor, with the consent of the owner, outside of the fence along Eastern Avenue.

SECTION 19 (DAY WORK), SIPHON, MALDEN RIVER, EVERETT AND MEDFORD.

Location. — From the end of the sewer already built (end of section 17½) on the easterly bank of Malden River, Everett, underneath the river, at a point about opposite the Wellington station of the Boston & Maine Railroad, to the sewer already built (beginning of Section 20) on the westerly bank, Medford.

Character of structures:

Everett side, —	
Brick sewer, 4 feet 8 inches by 5 feet 1½ inches, with a branch 3 feet 6 inches in diameter. Length, about	40 feet.
Pipe chamber (including a sump man-hole, 3 feet 6 inches square; a stop plank man-hole, 4 feet 8 inches by 6 feet 2 inches, containing a branch for an overflow; an enlarger connecting these two man-holes, built upon a vertical reversed curve, with a rise of 7 feet). Length, about	35 "
Under the Malden River, —	
Concrete pipe, 3 feet 6 inches inside diameter. Length, about . .	229 "
Medford side, —	
Sand-catcher, 10 feet by 11 feet 3 inches, with three stop plank man-holes (one connecting with pipe laid under the river, one connecting with the overflow and one to connect with an additional pipe to be laid under the river in future if found necessary). Length, about .	88 "
Brick sewer, 4 feet 8 inches by 5 feet 1½ inches. Length, about . .	104 "

State Assistants.

Assistant Engineer: William W. Lewis.
Foremen: Patrick McCarthy, Charles P. Horton, Samuel Taylor (pile driving).
Transitmen: Edward S. Foster, George A. Winsor.
Draughtsman: David H. Winslow.

Trench, Everett Side.

Total cubic yards of excavation, ... 776

Approximate cost of excavation per cubic yard, including sheeting and bracing, pumping and building peat dam around trench, $4.50.

Character of Earth Excavation. — Peat and silt.

Masonry, Everett Side.

Volume of Portland concrete built,	304 cubic yards.
Volume of Portland brickwork built,	48 " "
Approximate cost of Portland concrete per cubic yard,	$5 50
Approximate cost of Portland brickwork per cubic yard,	18 20
Approximate cost of pipe chamber,	6,281 00
Approximate cost of 40 feet of 4 feet 8 inches by 5 feet 1½ inches sewer,	1,554 00

Coffer-dam across Malden River.

Length completed,	225.00 feet.
Elevation of top of plank,	114.20 "
Average width inside of sheeting,	9.00 "
Length of the 4 inch spruce sheeting: —	
For 147 feet from the Everett side,	35.00 "
For the remaining 78 feet, on the Medford side,	30.00 "
Number of round piles,	56
Number of spur and dolphin piles,	46

Began to build on Everett side May 15, 1894.

Finished Everett side July 13. Cut away Everett side July 27.

Channel opened on Everett side and closed on Medford side August 4.

Coffer-dam finished, Medford side, August 18. Cut away, Medford side, September 25.

Cut away, centre piece, September 26.

Approximate cost of coffer-dam per linear foot, including all bracing, to date (September 30), $19.60.

Excavation across Malden River.

Length completed,	229.00 feet.
Average depth of excavation from the bed of Malden River to bottom of trench,	12.70 "
Greatest depth of excavation from the bed of Malden River to bottom of trench,	21.00 "
Average width of trench,	9.00 "
Greatest depth of trench below mean high water,	22.00 "

Volume of excavation per linear foot, 4.2 cubic yards.

Excavation began on Everett side June 12, 1894. Finished July 16.

Excavation began on Medford side August 20. Finished August 24.

Approximate cost per linear foot, including pumping, to date (September 30), $6.85.

Character of Earth Excavation. — River mud and silt. Some sand in places at the bottom. Sulphuretted hydrogen was present in small quantities.

Masonry, Malden River.

Length completed,	229.00 feet.
Volume of concrete per linear foot of pipe,	.31 cu. yds.

Approximate cost of sewer pipe per linear foot, including cradling and concrete, $11.12.

Began to build pipe on Everett side June 20; finished July 26.

Began to build pipe on Medford side August 29; finished September 21.

Trench, Medford side.

Cubic yards of excavation to date (September 30),	264

Character of Earth Excavation. — Peat and silt.

Total approximate cost of section, including coffer-dam, trench, masonry, etc., to date (September 30), $24,400.

The work for this year (ending Sept. 30, 1894) has consisted principally of constructing about 40 feet of sewer and the pipe chamber on the Everett side, and the concrete pipe siphon under the bed of the river.

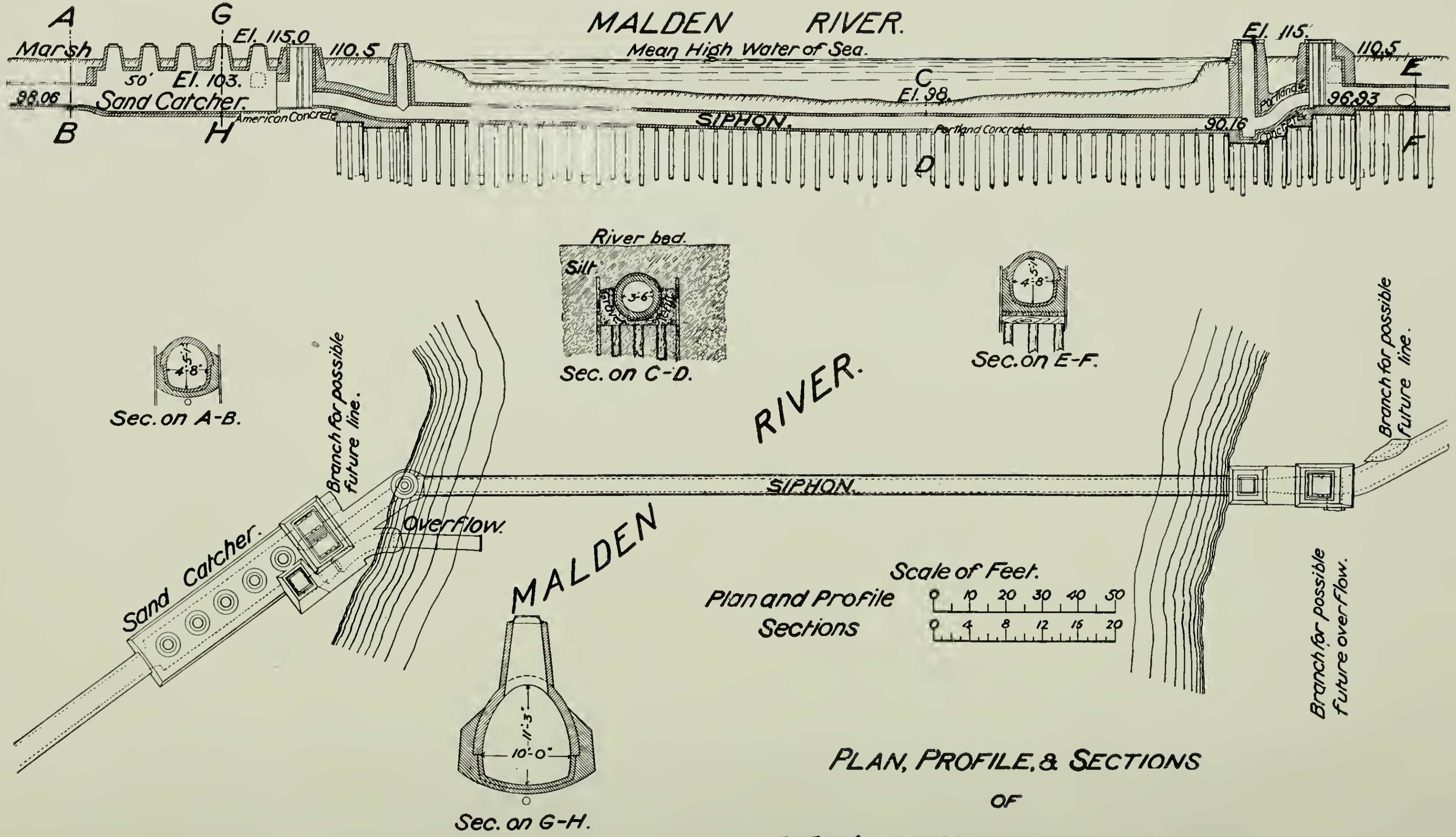
All of the masonry built in this section has rested on a pile foundation. That portion of the section not under the river bed is situated on a marsh about 1,400 feet on the Everett side and 500 feet on the Medford side from hard ground. These marshes are great obstacles to getting supplies for construction to the place where needed. The preparations for work in a place like this form a large part of the entire cost of construction.

At the point where the sewer crosses it the river has a width at high water of 229 feet. Its depth at mean high water is about 12 feet. The average tidal current is about 1 foot per second.

Construction of Brick Sewer and Pipe Chamber on Everett Side. — Work began on May 7 by driving round piles around the end of the proposed trench in the river, for a coffer-dam made of 4 inch spruce plank. The coffer-dam was carried to elevation 114.2, or a little more than 3 feet above the surface of the marsh. The remaining portions of the trench were protected by a dam built with the peat excavated from the trench. This had the same elevation as the coffer-dam. This dam was made necessary for the reason that at high courses of tides the marsh was sometimes flooded to a depth of 2 feet. Excavation began May 15. The pipe chamber was built of Portland cement concrete, lined with 8 inches of brick.

The surface of the structure above the marsh and towards the river was faced with granite. But very little water was found in the trench. The work here is practically finished.

Construction of the Sewer across Malden River. — In order that the navigation of the river should not be obstructed, it was necessary that the work be done upon one side at a time. The coffer-dam was built out from the Everett side for a length of 113 feet, leaving an open channel at high water of about 112 feet. After the sewer had been completed in this part of the coffer-dam, 82 feet of the dam, from the Everett side, was cut away and the channel opened. This left a box-shaped section of the coffer-dam 31 feet long in the middle of the river. The coffer-dam was then built from this centre portion to the Medford side. In each case where there was an exposed end of the coffer-dam in the river it was protected by pile dolphins, a little in advance of the main structure. Water burst into the coffer-dam in two places: the first, under the sheeting, was easily stopped with a



PLAN, PROFILE, & SECTIONS OF SIPHON UNDER MALDEN RIVER.

loss of but two days' time; the second, through the bulkhead between the centre portion and the open channel on the Everett side, caused more trouble, as the water burst in several times. The inflow was each time stopped by the use of sand bags and silt.

An "A" frame derrick, running upon the top of the coffer-dam, hoisted the excavated material and dumped it over the side into the river. This derrick was supplemented on the Medford side by a boom rigged on the pile driver, which was used to hoist. The material dumped in the river helped to make the coffer-dam tight, and facilitated the cutting of the sheeting and the sawing of the piles, and was also convenient for use as back-filling. The surplus material was removed from the river after the trench was back-filled. A 2 inch Worthington pump, most of the time running at only about half its capacity, took care of all the water leaking into the trench.

The sewer is of Portland cement concrete, 8 inches thick. The outer shell of the sewer is spruce lagging, laid to break joints and placed in cradles made on the pile caps. At intervals of about 4 feet oak pins project 3 inches from these lagging strips into the concrete. The object of these pins is that any tensile strain on the concrete may be transmitted through them to the lagging strips. At intervals of 1 foot the pipe is surrounded by oak hoops, to give it strength to resist bursting pressure. To give additional lateral strength to the structure, the trench was back-filled with puddled fine bank gravel to the height of about 1 foot above the springing line of the sewer. About all that now (September 30) remains to be done is to cement-wash the inside of the siphon and remove the surplus earth from the river on the Medford side.

Construction of the Sand-catcher on Medford Side. — The sheeting cut off from the coffer-dam is being driven for the sheeting of the trench for the sand-catcher and for the trench of the sewer beyond to connect with Section 20. This sheeting will have to be driven for a length of about 193 feet. Forty-six feet have already been done. About a quarter of the excavation for the sand-catcher has been done to date (September 30), and 27 foundation piles have been driven. The masonry of the sand-catcher has just been begun.

SECTION 22, WEST MEDFORD.

Location. — Through Canal Street, from its junction with Prescott Street, and through Warren Street, crossing a brook near Irving Street, thence crossing private lands, Irving Street and private lands again and along the easterly side of the Boston & Lowell Railroad, across Grove Street to a point about 1,200 feet north of Grove Street, thence across the railroad and private land to near the Mystic dam.

Diameters of sewers and length of each size: —

3 feet 4 inches by 3 feet 6 inches, including bell-mouth at Alewife Brook branch,	6,033 feet.
2 feet 10 inches by 3 feet (Alewife Brook branch to Station 0 + 22),	18 "
4 feet 3 inches by 4 feet 6 inches (extension of Section 21 to bell-mouth near beginning of Section 22),	5 "

Contractor. — Andrew W. Bryne of West Medford, Mass. Mr. Bryne has acted as his own superintendent.

State Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Edmund S. Davis.
Inspector: Henry M. Woodward.
Transitman: Burton A. Clark.

Trench and Tunnel.

Length completed of trench excavation,	5,347.00 feet.
Length completed of tunnel excavation,	686.00 "
Average depth of trench excavation to bottom of underdrain,	23.00 "
Greatest depth of trench excavation to bottom of underdrain,	31.00 "
Average width, top of trench,	8.00 "
Average width, bottom of trench,	6.33 "
Average depth from surface of ground to bottom of tunnel underdrain,	28.00 "
Greatest depth from surface of ground to bottom of tunnel underdrain,	42.00 "
Average width of tunnel excavation,	5.50 "
Volume of trench excavation per linear foot,	6.06 cu. yds.
Volume of tunnel excavation per linear foot,	1.25 cu. yds.

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., $9.

Approximate cost of tunnel per linear foot, including excavation and refilling below masonry, back-filling, extra excavation on account of change of grade, etc., $8.50.

Character of Earth Excavation. — In Canal and Warren streets: about 2 feet of filling on the surface, then a stratum of sand and gravel to within about 5 to 8 feet of the bottom, where fine sand was found mingled with some clay. The only exception to this was for a length of about 128 feet in front of the stone yard, where there was about 4 feet of clay in the bottom. Through the field from Warren Street to within about 600 feet of Grove Street: from 8 inches to 1½ feet of soil on the surface, beneath which is coarse sand and gravel, then fine running sand in the lower part of the trench. In some places this fine running sand has clay mingled with it. The cross-section of the earth continues much the same to a point about 500 feet north of Grove Street, where coarse sand and gravel is found from the surface to near the bottom of the trench. The sand gradually grew finer towards the bottom. The last cross-section extends most of the distance to near the Mystic dam.

Masonry.

Contract prices : —

Brickwork, American cement mortar, per cubic yard,	$13 50
Brickwork, Portland cement mortar, per cubic yard,	15 50
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size : —

6 inch,	1,474 feet.
8 inch,	3,929 "
10 inch,	224 "

Approximate cost of masonry per linear foot of trench, including underdrain, cradling, etc., $6.

Approximate cost of masonry per linear foot of tunnel, including underdrain, etc., $7.40.

Length completed, in trench,	5,347 feet.
Length completed, in tunnel,	686 "

Masonry begun in trench March 24, 1892; finished Dec. 9, 1893.

Masonry begun in tunnel March 8, 1893; finished Dec. 4, 1893.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, $15.30.

NOTE. — The information regarding Section 22 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fourth and fifth annual reports.

Excavation.

	Open Cut.	Tunnel.
Number of headings,	-	One.
Point of continuing from last year's work.	About 670 feet south of Grove Street.	159 feet south of the northerly end of the tunnel near Grove Street.
Point of ending,	About 120 feet south of Grove Street.	About 120 feet south of Grove Street.
Date of finishing,	Nov. 24, 1893,	Nov. 27, 1893.
Length,	548 feet,	157 feet.
Ordinary progress per week,	68 feet,	30 feet.
Appliances used,	Trench machine,	Hand derrick.
Gang ordinarily employed,	30 men,	11 men.

A 6 inch centrifugal and a 3 inch Knowles pump, together with a No. 5 pulsometer, were used in pump-wells and sumps along the line as needed in order to keep down the ground water. The excavation was carried on without interruptions of any kind.

Foundation. — Along the easterly side of the railroad to Grove Street very fine running sand mingled with clay was found in the bottom of the trench. Beginning about 300 feet south of Grove Street and running southerly about 362 feet, this fine running sand and clay was excavated to a depth of 6 inches below the bottom of the masonry, and replaced by screened gravel. Elsewhere the bottom of the trench was of somewhat coarser sand mixed with clay. In open cut cradling was used, back-filled with sand and gravel. In the tunnels the brickwork rested on concrete.

Miscellaneous. — The operations were carried on without serious difficulties or accidents. The portion of the tunnel under the easterly abutment of Grove Street bridge was back-filled with concrete over the arch of the sewer. Most of the surplus earth gained from the sewer excavation was hauled away by the contractor. On account of the earth being frozen, grading of the surface along the slope of the railroad cut near Grove Street was not done until spring.

Section 25 (Day Work), Charlestown.

Location. — From the end of Section 24, Malden bridge causeway, southerly along the causeway to site of pumping station near the pile bridge; thence under Mystic River, 61 feet east from and parallel to Malden bridge, to Tufts' Mill Pond; thence under Tufts' Mill Pond to a point 266 feet northerly from Arlington Avenue, where connection is made with Section 25½.

Length of section: —

From end of Section 24 to pumping station,	335 feet.
At pumping station,	150 “
From pumping station to Section 25½,	1,055 “
Total,	1,540 “

Main Sewer, connecting Section 24 and Pumping Station.

Diameters of completed sewer: —

6 feet by 6 feet 8 inches,	174.00 feet.
6 feet by 7 feet 1 inch,	161.00 “

Assistants.

Assistant Engineer: Henry H. Marden, Jr.
Transitman: Principal — Frank C. Shepherd.
“ Assistant — Charles H. Smith.
Principal Foremen: B. L. Sykes, John Collaran.

Trench.

Length,	335.00 feet.
Average depth of excavation to bottom of underdrain,	23.10 “
Greatest depth of excavation to bottom of underdrain,	25.80 “
Average width, top of trench,	14.00 “
Average width, bottom of trench,	10.00 “
Volume of trench excavation per linear foot,	11.30 cu. yds.

Character of Excavation. — For the upper 7 feet, filling, sand and sandy clay. Below this, 10 feet of broken stone and ballast. Sandy silt the rest of the way down.

Masonry.

Length completed,	333 linear feet.

Masonry begun May 1, 1894; finished July 21.

Underdrain, 10 inches diameter,	4 feet.
Underdrain, 15 inches diameter,	327 “

Approximate cost of section per linear foot of excavation, pile foundation and masonry, including labor, material and miscellaneous items, $49.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open trench,	Open trench.
Date of starting,	March 29, 1894,	May 31, 1894.
Point of beginning,	22 feet from end of Section 24,	End of Section 24.
Point of ending,	Site of pumping station,	Opening No. 1.
Date of finishing,	June 13,	June 11.
Length,	313 feet,	22 feet.
Ordinary progress per week,	48 feet,	14 feet.
Machines used,	Trench machine,	Incline.
Gang ordinarily employed,	55 men,	15 men.

Pumping was done from a well located near the beginning of the section. One 9 inch centrifugal pump and one 6 inch centrifugal pump were required to handle the water. The estimated greatest rate of pumping per twenty-four hours is 1,440,000 gallons.

Foundation. — For a distance of 264 feet, from 1 to 3 feet of material was excavated from below the masonry, and the trench refilled with well-compacted gravel. The material removed was sandy silt, with some clay. For the remainder of its length (71 feet) a pile foundation was used. The soil was a sandy silt, underlaid by blue clay. Piles from 15 to 20 feet long were driven in bents, four in a bent, the bents four feet apart. The piles were capped with 8 inch by 10 inch spruce, and a platform of 4 inch spruce plank was laid on the caps.

Miscellaneous. — The West End Street Railway tracks extend along the street here, and to open the trench it became necessary to have one track removed, and the corporation has used one track for all the traffic at this point.

An old sea wall extends along one side of the causeway, and, to prevent tide-water from following along this, a section of the wall near the pile bridge was taken out and a concrete cut-off put in. After one section of sewer had been built at the beginning, and a cut-off put in at that point, the pumps could keep the trench clear of water at all times.

Surplus earth was dumped in Tufts' Mill Pond.

TUNNEL.

Diameters of tunnel structures and length of each size: —

Main siphon, 5 feet circular,	1,133 feet.
Reducer (5 feet circular to 6 feet 7½ inches by 7 feet 5½ inches),	50 "
Screen chamber (6 feet by 9 feet),	15 "

In addition there are three branches, each 3 feet 6 inches in diameter and about 5 feet long, leading to the pump-wells.

Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Henry H. Marden, Jr.
Superintendent of tunnel construction: Charles A. Haskin.
Foremen: Henry Hertz, John Duffy.
Transitmen: Principals — E. Elbert Young, Frank C. Shepherd.
" Assistant — Charles H. Smith.

Excavation (from Beginning of Work).

	Reducer.	Five-foot Circular Sewer.	Screen Chamber.	Branches.
Length completed, feet, ...	50.00	1,133.00	15.00	17.00
Average depth from surface of ground to bottom of brickwork, feet, ...	31.00	44.00	49.00	47.50
Greatest depth from surface of ground to bottom of brickwork, feet, ...	37.00	45.00	49.00	48.50
Average width of excavation, feet, . . .	8.67	7.00	8.00	5.50
Volume of excavation per linear foot, cubic yards,	1.09	1.71	3.02	0.91

Character of Earth Excavation. — Upper 11 feet of shaft: miscellaneous filling partially decomposed; next, sand; balance of shaft, clay, gravel and small stones. Northerly heading from shaft: clay and small stones for 330 feet; clay, stones with streaks of sand for 60 feet; clay and stones for 190 feet; clay, sand and river mud for 30 feet; clay and sand for 113 feet; all sand for 30 feet; clay and sand for 47 feet; clay to end of tunnel, 192 feet. Southerly heading: clay and stones, with occasional pockets of sand, for entire length.

Tunnel Masonry (from Beginning of Work).

Length of masonry completed, ... 1,198 feet.
Tunnel masonry begun July 3, 1893; finished April 9, 1894.
Approximate cost of masonry per linear foot, $25.60.
Approximate total cost for tunnel, including excavation, masonry, shaft, superintendence and miscellaneous items, $67,000.

NOTE. — The information regarding Section 25 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Construction. — The tunnel was driven from a shaft located about 50 feet southerly from retaining wall of Tufts' Mill Pond. Two drifts were worked; one, continuing from the work of 1893 (404 feet northerly from shaft), went northerly under the Mystic River to the end of the tunnel (992 feet from shaft); the second heading commenced February 26, at shaft, and ran southerly under Tufts' Mill Pond to end of section, Station 15 + 42, a distance of about 206 feet. The northerly drift was completed Jan. 25, 1894; the southerly drift, April 9, 1894. The ordinary progress per week in each heading was 35 feet. The excavation was carried on by a day and a night gang, and there were ordinarily 19 men in each. The plant for carrying on the work was the same as described last year, with the addition of another Westinghouse dynamo, with a capacity of 66 incandescent electric lights, and a horizontal boiler, 48 inches by 19 feet.

A No. 5 pulsometer sufficed to take care of the water from the tunnel and keep the shaft dry.

Beginning at a point 723 feet northerly from the shaft, the invert of the tunnel masonry was built with a brick spandrel for a distance of 30 feet. For the rest of the tunnel the material in the bottom was excavated to fit the invert of the masonry.

During work in the northerly heading bubbles of air had been seen to freely escape from the water above the tunnel. On the last day of October the agitation near the end of the drift under the river as then excavated was more violent than usual, and two compressors were required to keep up the air pressure in the tunnel. November 1, at 2 A.M., when the heading had advanced 620 feet from the shaft, air commenced to escape freely at the roof, allowing the water to enter. The men used their surplus clothing, together with small plank, wedges and mud, endeavoring to stop the hole where the air was escaping, but were forced to retreat to the lock. At this time the water was knee deep in the tunnel. The tunnel filled with water in about an hour. Soundings taken in the river the next morning showed a crater-like depression directly over the heading. It would appear that some time previous a boring had been made at this point, and when the air commenced to escape through it the mud stirred up by the escaping air was washed away by the current, gradually reducing the resistance to the escape of the air, and allowing the water to enter. The bed of the river was about 6 feet over the roof of the tunnel at this point. About 100 yards of clay were dumped from scows into the crater. Over this was spread a sail, 60 by 60 feet, and on the sail was dumped about 400 yards more of clay.

November 3, 3 P.M., compressors were again started to force the water from the tunnel. By November 6 the tunnel was entirely cleaned out, and work resumed.

November 14, at a point in the northerly heading about 666 feet from the shaft, a human skeleton was unearthed in the upper part of the tunnel.

PUMPING STATION AND CONNECTIONS (DAY WORK), CHARLESTOWN.

Location. — The Charlestown pumping station is located on the easterly side of the Malden bridge causeway, at the northerly end of the pile structures, and, with all connections, covers an area 150.50 feet long by 72 feet wide.

The Work comprises. — Engine house foundations, boiler house foundations, pump-wells and engine foundations, chimney foundations, screen man-hole, valve manholes, connections with tunnel, connections with main sewer and sea wall 179 feet long.

Work begun Jan. 23, 1894, and is still (September 30) in progress.

State Assistants.

Assistant Engineer: Henry H. Marden, Jr.
Transitmen: Principals — Frank C. Shepherd, E. E. Young.
" Assistants — C. H. Smith, George A. Winsor.
Foreman: James Long.
Sub-foremen: James Carroll, Matthew Brennan, John Doherty.
Foremen, pile-driver: Josiah Shaw, A. A. McCormack, Douglas Patterson.
Foreman, bricklayer: Michael Driscoll.
Foreman, stone-mason: John H. Etridge.
Foreman, carpenter: D. W. Wallace.
Foreman in charge of pumps: Robert Craib.

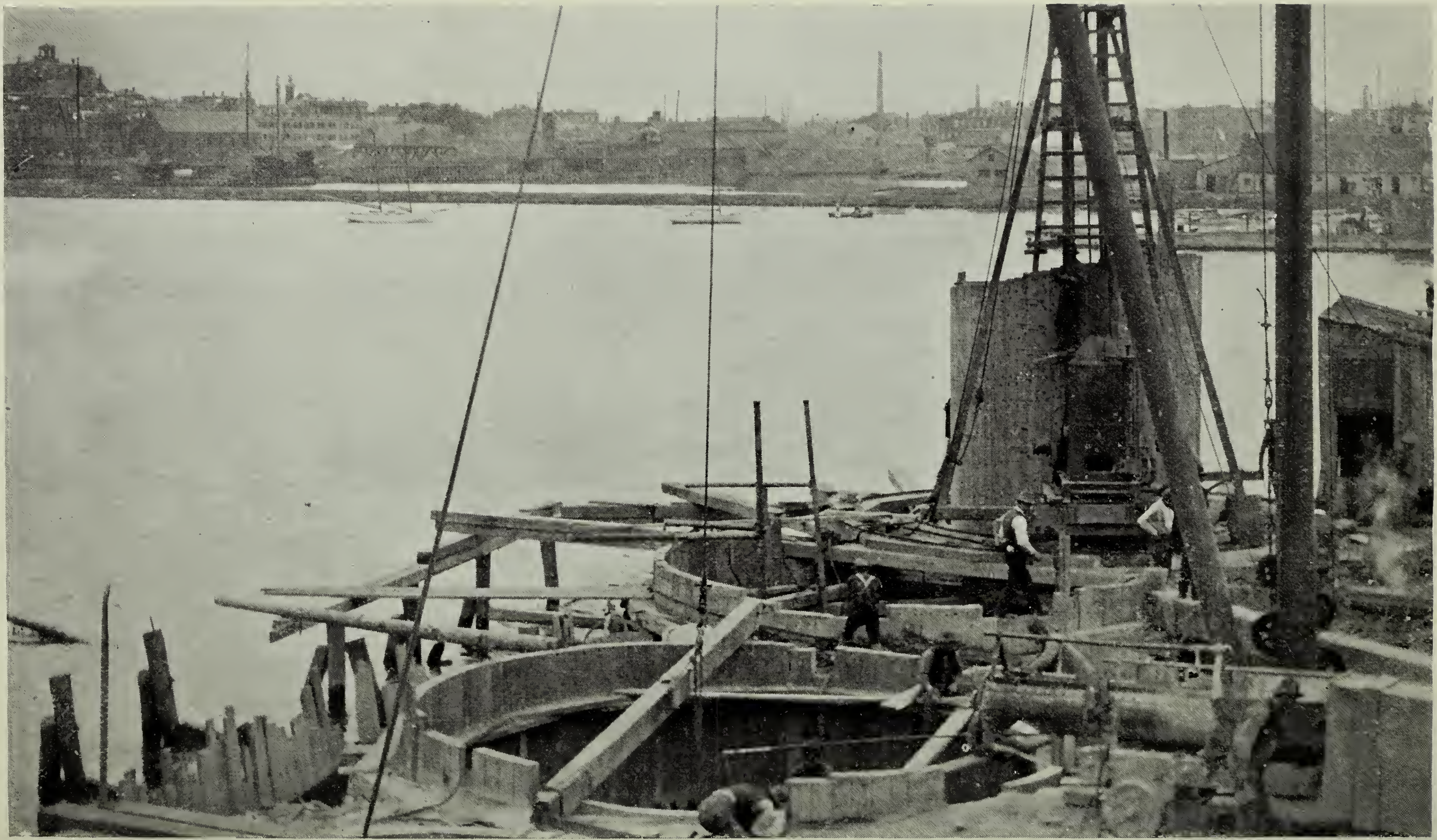
Approximate cost of pumping station to date (September 30), including foundations, sea wall, pump-wells, screen chamber, chimney, connections, etc., $63,000.

Sea Wall. — Jan. 16, 1894, a contract was made with Alex. McInnes of East Boston for driving the foundation piles for the sea wall and engine foundations. The contractor commenced Jan. 23, 1894, and finished March 8. The total amount of piles driven under this contract was 11,050 linear feet, at 10½ cents per linear foot, costing $1,160.25.

Piles were driven in bents of 4, bents 2 feet 6 inches apart on centres. Between bents, 2 piles on a batter of 1 in 48 were driven. Piles were cut off at about low tide, and capped with 3 inch by 12 inch spruce timber laid longitudinally with the wall. On the caps was laid a solid platform of 3 inch spruce plank. The sea wall built on this platform is 10 feet wide at the bottom, 4 feet wide at the top and is 16 feet high. It consists of a face of quarry-split granite, backed with Portland cement concrete. In the concrete rough blocks of stone were bedded.

The wall was commenced August 26, and is in process of construction.

The chimney foundation consists of granite 16 feet square on bottom and 11 feet 10 inches square on top. It is built on 49 piles, 35 feet long, driven in 7 bents, 7 piles to a bent. The piles



Pumping Station, Charlestown. Coffer-dams for Two of the Pump Wells. June 6, 1894.

are 2 feet 6 inches apart on centres. They are sawed off at elevation 103.13, capped with 6 inch by 12 inch spruce, on which a platform of 6 inch spruce is laid. The top of the chimney foundation is at elevation 115.5.

Excavation for chimney began June 16, 1894.
Pile driving began June 21.
Began laying stone August 1.
Finished laying stone August 13.
Cost of chimney foundation, $1,466.

Pump-wells and Engine Foundations.

Diameter of excavation, ...	23 feet.
Depth of excavation from top of coffer-dam, ...	51 "

Character of Excavated Material. — For 19 feet below the street level, water, which was pumped out. For 19 feet further, sandy silt; then a foot of water bearing coarse gravel. The last 12 feet were soft blue clay.

PROGRESS.	Well No. 1.	Well No. 2.	Well No. 3.
Sheeting closed in, ...	May 5.	April 16.	March 22.
Began excavation, ...	May 9.	April 17.	March 26.
Began excavation at elevation, ...	98.00	98.00	101.00
Finished excavation, ...	June 29.	May 4.	April 16.
Finished excavation at elevation, ...	66.00	65.60	65.50
Began concrete, ...	June 30.	May 5.	April 17.
Elevation of concrete, September 30, ...	109.00	109.00	116.33

An examination of the plan and profile opposite pages 78 and 79 will aid in understanding this part of the work.

The coffer-dam for sinking these wells was made as follows: 11 piles were driven in a circle of 25 feet diameter for each well. To these piles, wales, sawed to fit circle 23 feet diameter for inside and 24 feet diameter for outside of sheet piling, were bolted. The sheet piling was built up in lengths of 49½ feet, three thicknesses of 2 inch plank sawed and planed to uniform width and thickness being used. The middle plank laps by the two outside ones to form a 2 inch tongue and groove. The planks were fastened together with ½ inch bolts spaced about 3 feet apart. This sheeting did not prove to be very stiff, and was easily deflected from its position. Before driving, the sheeting for a pit was set up to form the complete circle. A pile-driver arranged with overhanging gins and a special-shaped hammer, set upon a track concentric with the sheeting, was used for driving. The sheeting was driven for the entire circumference, a foot or two at a time. After the pits were closed in and the sheeting driven, they were pumped out by pulsometers.

The material excavated from the pits was deposited outside of the sheeting to help make the coffer-dam. As excavation inside of wells proceeded, the sheeting was braced by a curved rib of two thicknesses of 3 inch spruce, sawed to proper radius and built up to break joints. This rib was stiffened by 8 inch by 8 inch spruce braces. The ends of the braces were fastened by 1 inch iron pins to the ribs, and at every intersection of the braces pins were put in. After being put in and fastened together, there was no perceptible distortion of the frame. In excavating, many planks were found out of position, some as much as 2 feet into the well. These were cut off, and poling plank substituted. In wells 1 and 2 water broke in several times, and on well 1 tide work was necessary. The proximity of an old sea wall was the main cause, it being hard to locate the point where water found an entrance.

Screen Man-hole. — Sheeting was driven similar to that on pump-wells. On excavating it was found that the sheeting was driven out of position so much that it was necessary to cut it out below elevation 98.

Diameter of excavation, ...	12 feet.
Depth of excavation below top of coffer-dam, ...	37 "

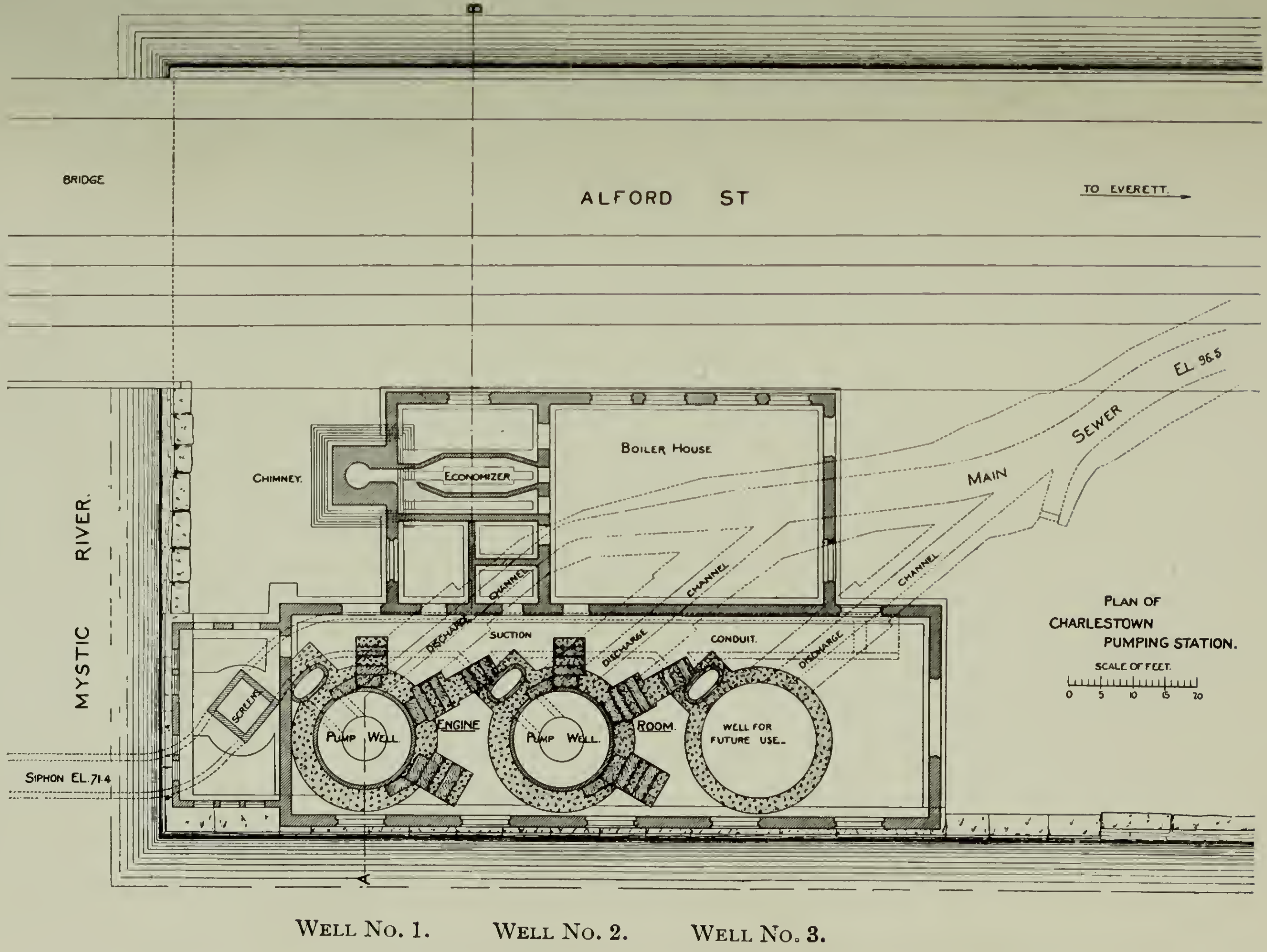
Sheeting closed in May 28. Excavation began June 9, but was suspended until July 30. Sheeting cut out and excavation finished to top of tunnel (elevation 80), September 30.

Connections with Main Sewer. — These comprise three discharge tubes, each 36 inches diameter and 36 feet long; a reducer from 6 feet by 7 feet 1 inch to 36 inches, and a double bell-mouth at the junction of the main sewer with the discharge from pump No. 3 and the discharge from pump No. 4.

Of these connections, the bell-mouth and reducer are complete, and considerable excavation has been done on the trenches for the discharge channels.

No work has been done on the connections with the tunnel.

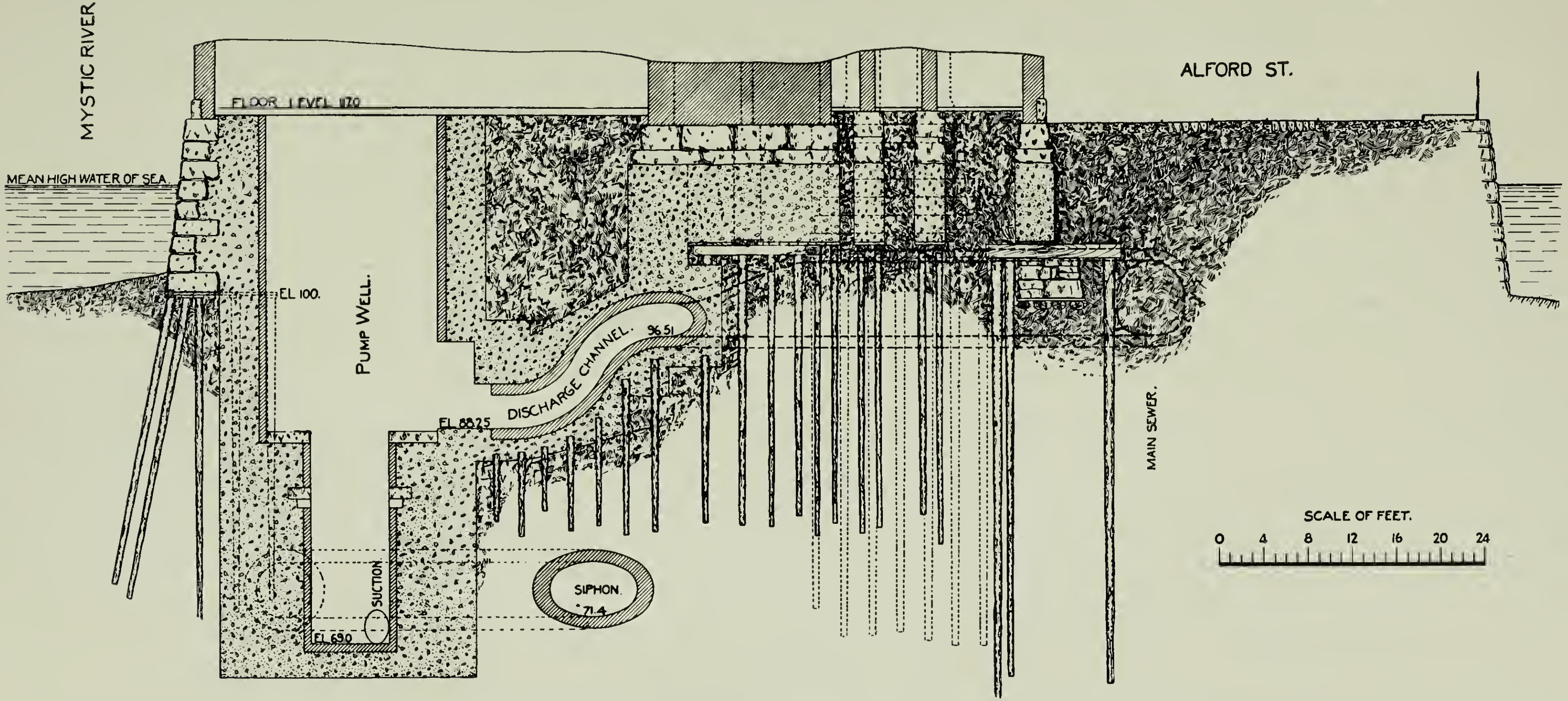
Boiler House Foundations. — Only the west foundation, with the north and south corners, has been built thus far. The west wall is directly over an old sea wall which runs along under the causeway. This old wall was taken out to about a foot below half tide, and the foundation wall built over it. Forty foot piles, cut off at elevation 103.42, were driven each side of the old wall, and 10 inch by 16 inch hard pine caps laid on them. A solid platform of 3 inch spruce was laid on the caps, and on this the foundation wall of concrete, 42 inches thick and 7 feet high, was built.



PLAN OF
CHARLESTOWN
PUMPING STATION.

— CHARLESTOWN —
— PUMPING STATION —

SECTION ON LINE A-B.



Elevations are referred to a datum $100\frac{64}{100}$ below mean low water of the sea.

Engine House Foundations. — The east side of the engine house rests on the sea wall; the foundation for the north wall, now built, consists of a concrete wall on pile foundation. Piles were driven in bents of 3 piles, bents 2 feet centre to centre, cut off at elevation 104.5, capped with 3 inch by 12 inch spruce lengthwise of the wall, on which a platform of 3 inch spruce plank was laid. The wall was built of Portland cement concrete, 7 feet wide at the bottom, 4 feet at the top and 7 feet high, in which large stones were bedded at random.

Plant. — The plant used on the pumping station work comprises two inclines, one pile-driver, one floating pile-driver, two steam derricks, two scows, six pulsometer pumps and two 6 inch centrifugal pumps.

Miscellaneous. — The ordinary gang employed was one hundred men. August 13 the men struck, and the difficulty was adjusted on August 17, when the men returned to work.

A contract for the building has been made with Edward Lynch & Co., but no work has been done (September 30) under the contract as yet.

Accident. — On July 27 Patrick McCool, a laborer, fell into the pit in which chimney foundation was to be placed, and broke his leg at the hip. He was taken to the Massachusetts General Hospital.

Section 25½ (Day Work), Charlestown.

Location. — Parallel to Alford Street, through Tufts' Mill Pond, from a point 250 feet west of Mystic River to within about 475 feet of Main Street.

Diameters of sewers and length of each size: —

6 feet 7 inches by 7 feet 5 inches, about	320 feet.
6 feet 5 inches by 7 feet 2 inches, about	265 "

Assistants.

Assistant Engineer: Frank I. Capen.
Foreman: Patrick McCarthy.
Transitmen: Principal — Hartley L. White.
" Assistants — Harry L. Ward, E. I. Marvell.

Tunnel Excavation.

Length completed,	585 00 feet
Average depth from surface of ground to bottom of tunnel underdrain,	27.30 "
Greatest depth from surface of ground to bottom of tunnel underdrain,	31.50 "
Average width of excavation,	10.00 "

Cubic yards excavation per linear foot, 5.4.

Approximate cost of tunnel excavation per linear foot, including back-filling, lighting, etc., $25.50.

Character of Earth Excavation. — Two hundred and fifty feet south of retaining wall at Mystic River, top of tunnel excavation to 4½ feet above water line of sewer, hard clay; beneath, to bottom of underdrain, sand and gravel with some clay; opposite Arlington Avenue, compact clay; upper end of section, gravel and clay

Brick Masonry.

Volume of brickwork per linear foot,	1.06 cubic yards.
Diameters of underdrain laid and length of each size: —	
4 inch,	10 feet.
6 inch,	10 "
8 inch,	528 "
Length of masonry completed,	580 "

Masonry begun Oct. 19, 1893; finished May 4, 1894.

Approximate cost of masonry per linear foot, $15.

Approximate cost of this work per linear foot, tunnel and masonry, including labor, material, etc., $40.50.

Excavation, etc. — A tunnel shaft was started Oct. 2, 1893, at a point about 400 feet east of Main Street and 40 feet south of Alford Street. Tunnelling from this shaft was carried north for a distance of about 585 feet. The date of finishing was May 4, 1894. The ordinary progress per week was about 26 feet. The work was carried on in two eleven-hour shifts per twenty-four hours, fifteen men ordinarily working in each shift. An incline was used at the top of the shaft, to which the material was brought by buckets on trucks running on rails in the tunnel.

The pumping for nearly the whole section was done by one 2½ inch Worthington pump, at a shaft 400 feet east of Main Street. For the last 200 feet excavated an additional pump of the same kind was used at the man-hole shaft 600 feet east of Main Street. The line of the tunnel had been filled over with dump material and earth from Section 25 tunnel before excavation began. The tunnelling was done by the ordinary timber method, and the heading was closely followed by the brickwork.

Foundation. — The bottom of the entire tunnel was in clay, hard-pan and gravel, and this was excavated to fit the invert of the sewer.

Accidents. — Feb. 15, 1894, water softened the clay around the foot of the legs of the tunnel drift, causing the legs and the roof above to settle for a length of about 20 feet. This began about 320 feet from the beginning of the section. In order to repair this settlement, it was necessary to make a cut from the surface for a distance of 32 feet. The additional expense on account of this accident was approximately $1,000.

Miscellaneous. — The masonry for the whole length of this section, except at the shafts, was 12 inch brickwork. The material excavated from the tunnel was used for additional filling over and adjacent to the line of the sewer.

SECTION 27 (CONTRACT WORK), SOMERVILLE AND CAMBRIDGE.

Location. — From the corner of Joy and Poplar streets to and across Somerville Avenue, land of North Packing and Provision Company, to and through Medford Street and to and across the Fitchburg Railroad tracks; thence by way of Warren, Cambridge and Portland streets to near Binney Street.

Diameters of sewers and length of each size: —

5 feet 9 inches by 6 feet 6 inches, ...	770 feet.
5 feet 2 inches by 5 feet 9 inches, ...	3,556 "

Contractors (original). — McGovern & Kitch of Lancaster, Penn.

State Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Frank I. Capen.
Inspectors: John D. Collins, James E. Coyne.
Transitmen: Principal — Hartley L. White.
" Assistants — Harry L. Ward, Wm. H. Boardman, Jr., Edward I. Marvell.

Trench and Tunnel.

	Larger Sewer.	Smaller Sewer.
Length completed of trench excavation, feet, ...	770.00	2,520.00
Length completed of tunnel excavation, feet, ...	-	1,037.00
Average depth of trench excavation to bottom of underdrain, feet, .	24.40	22.90
Greatest depth of trench excavation to bottom of underdrain, feet, .	26.40	24.80
Average width, top of trench, feet, ...	9.00	8.80
Average width, bottom of trench, feet, ...	9.00	8.50
Average depth from surface of ground to bottom of tunnel underdrain, feet, ...	-	25.50
Greatest depth from surface of ground to bottom of tunnel underdrain, feet, ...	-	26.00
Average width of tunnel excavation, feet, ...	-	7.00
Volume of trench excavation per linear foot, cubic yards, . . .	8.10	7.30
Volume of tunnel excavation per linear foot, cubic yards, . . .	-	2.20

Character of Earth Excavation. — At Linwood Street: 5 feet gravel filling, 1 foot of peat, 3 feet of sand and gravel, then clay to grade; Medford Street, at Fitchburg Railroad: 12 feet of gravel filling, blue clay to grade; at Cambridge Street: 6 feet of gravel filling, 2 feet of peat, 7 feet of sand, and blue clay below to grade; in Portland Street: average is 7 feet of gravel filling, 7 feet of sand, blue clay to grade.

Masonry.

Diameters of underdrain laid and length of each size: —

6 inch, ...	1,242 feet.
8 inch, ...	2,464 "
10 inch, ...	314 "
12 inch, ...	267 "

Length of masonry completed: —

Larger sewer (in trench), ...	770 feet.
Smaller sewer (in trench), ...	2,508 "
Smaller sewer (in tunnel), ...	1,048 "

Masonry begun in trench June 29, 1892; finished Sept. 7, 1893.
Masonry begun in tunnel April 12, 1893; finished Nov. 25, 1893.

NOTE. — The information regarding Section 27 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fourth and fifth annual reports.

All the work described this year has been done by the Metropolitan Construction Company, who were the lowest bidders in the re-letting referred to in last year's report.

Excavation. — The excavation this year has been by two headings from the tunnel shaft started Sept. 1, 1893, on Warren Street, between Porter and Jefferson streets. The excavation in these headings, respectively, extended 250 feet north and 225 feet south of the shaft. The ordinary progress per week for both headings aggregated 25 feet. A mining hoist and trucks were used in removing the excavated earth. The gang employed was ordinarily twenty men, and two single teams, for both headings. Excavation was completed Nov. 25, 1893. A 3 inch pulsometer pump was used at the tunnel shaft to take care of the water. The bottom of the trench was excavated to fit the invert of the sewer on all of this year's work. About 250 feet north of Cambridge Street a vein of soft material was encountered in the roof of the tunnel. A portion of this material ran out, and left a space over the roof. The earth above settled and filled the space, and caused a settlement of the street surface about 10 feet wide, 15 feet long and 2 feet deep. The surplus earth from the tunnel was deposited to fill low land along the line of the sewer.

SECTION 28, CAMBRIDGE.

Location. — From a point in Portland Street, about 50 feet north of Binney Street, through Portland and Albany streets, across Front Street and through Albany Street extension to Waverly Street at Allston Street; thence through Waverly Street to Chestnut Street.

Diameters of sewers and length of each size: —

Bell-mouth, 5 feet 2 inches by 5 feet 9 inches to 4 feet by 4 feet 6 inches,	14 feet.
Main sewer, 4 feet by 4 feet 6 inches,	6,489 "

Contractors. — John L. Reardon & Co. of Brighton, Mass.

Contractors' Superintendent. — Thomas J. Young, a member of the above-mentioned firm.

Contractors' Principal Foreman (*Year ending Sept. 30, 1894*). — James McManus.

State Assistants (*Year ending Sept. 30, 1894*).

Assistant Engineer: Frank I. Capen.
Inspectors: Caleb Kimball, James E. Coyne.
Transitmen: Principal — Hartley L. White.
" Assistants — Harry L. Ward, Wm. H. Boardman, Jr., Edward I. Marvell.

Trench and Tunnel.

Length completed of trench excavation,	6,424.00 feet.
Length completed of tunnel excavation,	79.00 "
Average depth of trench excavation to bottom of underdrain,	19.20 "
Greatest depth of trench excavation to bottom of underdrain,	23.50 "
Average width, top of trench,	8.80 "
Average width, bottom of trench,	7.50 "
Depth from surface of ground to bottom of tunnel underdrain,	23.00 "
Average width of tunnel excavation,	7.50 "

Cubic yards trench excavation per linear foot, 5.30.
Cubic yards tunnel excavation per linear foot, 2.20.
Approximate cost of trench and tunnel per linear foot, including excavation and refilling below masonry, back-filling, sheeting left in, etc., $7.

Character of Earth Excavation. — At Hampshire Street: 8 feet of gravel, with blue clay below to grade. Near Main Street the cross-section of earth is about 6 feet of gravel, 4 feet of peat, with fine sand below to grade. The peat stratum dips and the sand becomes coarser, until at about 500 feet south of Front Street the cross-section is 2 feet of gravel, 10 feet of peat and sand below to grade. In Waverly Street: 3 feet of gravel, sand below to grade.

Masonry.

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$12 15
Brickwork, Portland cement mortar, per cubic yard,	13 75
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	6 50

Diameters of underdrain laid and length of each size: —

8 inch,	1,774 feet.
10 inch,	2,481 "
12 inch,	2,247 "

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, etc., $5.50.

Length completed, trench,	6,424 feet.
Length completed, tunnel,	79 "

Masonry begun in trench Nov. 29, 1892; finished Dec. 26, 1893.
Masonry begun in tunnel Sept. 28, 1893; finished Oct. 18, 1893.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, $12.70.

NOTE. — The information regarding Section 28 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation and Foundation.

	EXCAVATION BY OPENINGS.		
	Old Opening.	Old Opening.	New Opening.
Character of opening,	Open cut,	Tunnel,	Open cut.
Number of tunnel headings.	-	One,	-
Date of starting,	May 10, 1893,	Sept. 18, 1893,	Nov. 20, 1893.
Point of beginning,	-	-	Southerly side of Bristol Street at Portland Street.
Point of continuing from last year's work.	400 feet north of Front Street on Albany Street.	Centre of Main Street at Portland Street.	-
Point of ending,	300 feet south of Front Street.	Southerly side of Main Street.	Northerly side of Bristol Street.
Date of finishing,	Nov. 24, 1893,	Oct. 18, 1893,	Dec. 26, 1893.
Length,	775 feet,	39 feet,	68 feet.
Ordinary progress per week.	95 feet,	20 feet,	15 feet.
Appliances used,	Trench machine at first, 100 feet by incline, 375 feet thrown out by hand.	Incline,	Incline.
Gang ordinarily employed.	40 men,	6 men,	10 men.

A 6 inch Webber pump was used at Main Street for taking care of the water, and afterwards was moved to and used on Bristol Street. In the Bristol Street opening clay in the bottom of the trench was excavated to fit the invert of the sewer. The tunnel under Main Street was through fine running sand. The heading was driven by using heavy lumber and 3 inch sheeting. The sheeting was closely driven, and all interstices were filled with marsh hay. This method of working almost entirely stopped the inflow of sand, except directly at the heading and a slight inflow at the lower edge of the side sheeting. From Main Street to about 300 feet south of Front Street the bottom of the trench was in sand. The sand removed to admit of laying the underdrain was replaced by gravel to a depth of about 8 inches.

Difficulties. — As has already been mentioned, the sewer tunnel under Main Street was through fine running sand. Owing to the unstable character of this sand, a slight settlement occurred over the line of the sewer. The street traffic was stopped altogether for a short time, and there was a little further delay because for a while only one track of the street railway could be used. About 250 feet of the sewer south of Front Street was built through a tidal pond. The portion of the pond where the sewer was to be built was separated from the main body by an earthen dyke. The water in the enclosed portion was pumped out and the work of building the sewer then proceeded. The top of the sewer arch is here about 3½ feet below the bed of the pond, and in addition to the refilling to the bed of the pond the arch is protected by a 6 foot embankment.

Miscellaneous. — The surplus earth has been used for filling low land adjacent to the streets through which the sewer is built.

SECTION 29, CAMBRIDGE.

Location. — From a point in Waverly Street, near the north corner of Chestnut Street, through Waverly Street, private way, Granite Street, private land, River, Blackstone, Albro and Ampere streets to Western Avenue.

Diameters of sewers and length of each size: —

4 feet by 4 feet 6 inches,	1,740 feet.
3 feet 8 inches by 4 feet 2 inches,	1,322 "
3 feet 6 inches by 4 feet,	2,095 "

Contractors. — Lindsey & Cudmore of Somerville, Mass.

Contractors' Superintendent (Year ending Sept. 30, 1894). — William Lindsey, a member of the above-mentioned firm.

Contractors' Principal Foreman (Year ending Sept. 30, 1894). — John Doherty.

State Assistants (*Year ending Sept. 30, 1894*).

Assistant Engineer: Frank I. Capen.
Inspector: Samuel Corning.
Transitmen: Principals — C. Barton Pratt, Frank C. Shepherd.
" Assistants — Wm. M. Stodder, Edward I. Marvell, Harry L. Ward.

Trench.

	4 feet by 4 feet 6 inches sewer.	3 feet 8 inches by 4 feet 2 inches sewer.	3 feet 6 inches by 4 feet sewer.
Length completed (feet),	1,740.00	1,322.00	2,095.00
Average depth of excavation to bottom of underdrain (feet),	16.20	12.90	18.00
Greatest depth of excavation to bottom of underdrain (feet),	21.50	18.20	20.00
Average width, top of trench (feet),	9.00	7.25	7.00
Average width, bottom of trench (feet),	7.00	7.25	5.75
Volume of excavation per linear foot (cubic yards),	5.06	3.50	4.20
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, backfilling, etc.,	$4 70	$3 50	$4 30

Character of Earth Excavation. — For first 2,000 feet, 12 feet of sand above about 5 feet of wet gravel; next 900 feet, about 5 feet of peat above about 5 feet of sand, with gravel to the bottom of the sewer; thence to a point about 300 feet from River Street, all peat; across River Street to Blackstone Street, gravel filling and sand; Blackstone Street to 150 feet from end of section, gravel filling on top of clay; last 150 feet, all clay.

Masonry.

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$12 00
Brickwork, Portland cement mortar, per cubic yard,	13 50
Concrete, American cement mortar, per cubic yard,	4 75
Concrete, Portland cement mortar, per cubic yard,	6 50

Diameters of underdrain laid and length of each size: —

6 inch,	298 feet.
8 inch,	1,778 "
12 inch,	2,992 "

Approximate cost of masonry per linear foot of trench, including underdrain, pile foundation, etc.: —

4 feet by 4 feet 6 inches and 3 feet 8 inches by 4 feet 2 inches sewer,	$6 00
3 feet 6 inches by 4 feet sewer,	7 60

Length of masonry completed: —

4 feet by 4 feet 6 inches sewer,	1,740 feet.
3 feet 8 inches by 4 feet 2 inches sewer,	1,322 "
3 feet 6 inches by 4 feet sewer,	2,095 "

Masonry begun April 30, 1894; finished Feb. 13, 1894.
Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, $10.90.

Note. — The information regarding Section 29 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening,	Open cut, . . .	Open cut, . . .	Open cut.
Date of starting, .	April 20, 1893, . .	Sept. 26, 1893, . .	Nov. 20, 1893.
Point of beginning, .	–	Corner of Blackstone and Albro streets.	Blackstone Street at River Street.
Point of continuing from last year's work.	Near Pleasant Street,	–	–
Point of ending, .	River Street, . .	Western Avenue, .	Blackstone and Albro streets.
Date of finishing, .	Jan. 31, 1894, . .	Nov. 21, 1893, . .	Dec. 13, 1893.
Length, ...	885 feet, . . .	516 feet, . . .	428 feet.
Ordinary progress per week.	150 feet, . . .	60 feet, . . .	100 feet.
Appliances used, .	Trench machine, .	Incline, . . .	Trench machine.
Gang ordinarily employed.	39 men, . . .	16 men, . . .	28 men.

A 6 inch Webber centrifugal pump at a well near the foot of Pleasant Street handled the water of the trench as far as River Street. Westward from that street no pump was required.

Foundation. — For a distance of about 1,000 feet from the centre of River Street to the end of the section the sewer rests on a clay bottom which was excavated to fit the invert of the sewer. From opposite the foot of Pleasant Street to River Street, a distance of about 1,100 feet, the bottom of the trench was peat. A pile foundation was here employed. The piles were 10 inches in diameter, and were driven in bents of three. The bents were 4 feet apart. The piles were capped with 8 inch by 10 inch caps, surmounted by a 3 inch platform. The piles were mostly 15 to 20 feet in length, but some were 18, 30 and 40 feet. For about 150 feet across the creek near River Street 40 foot piles were used.

Difficulties. — While building the sewer across the creek at River Street the trench was several times flooded by high tides. The masonry was here increased by adding concrete, over which a flagstone was laid in the bed of the creek with slopes of riprap to the grade of the marsh. The width of the surface covered by this riprap was that of the land-taking, i. e., 20 feet.

Miscellaneous. — In back-filling the trench on Blackstone Street a water pipe was broken. As a result, two near-by basements were flooded, slightly damaging goods contained in one. During a portion of the time while work was carried on at River Street, one track of the street railway could not be used, but, as the other could always be used, no considerable interference with travel was caused. The surplus earth gained by the displacement of the sewer was left on the marsh land near at hand.

SECTION 30, CAMBRIDGE.

Location. — From Western Avenue at the end of Ampere Street across Western Avenue and through private land to DeWolfe Street; through DeWolfe and Dyke streets and private land to and across Dunster Street; through private land and across Boylston to Eliot Street; and through Eliot Street, Eliot Square and Mt. Auburn Street to Lowell Street.

Diameters of sewers and length of each size: —

3 feet 5 inches by 3 feet 8 inches,	2,190 feet.
2 feet 10 inches by 3 feet; 2 feet 8 inches by 2 feet 10 inches,	3,032 "
2 feet 3 inches by 2 feet 4 inches,	1,810 "

Contractors. — Jones & Meehan of Jamaica Plain, Mass.

Contractors' Superintendent. — Michael Meehan, a member of the above-mentioned firm.

Contractors' Principal Foremen. — Peter Dolan, John Monehan.

State Assistants (Year Ending Sept. 30, 1894).

Assistant Engineer: Frank I. Capen.
Inspectors: George F. Greenlaw, Warren A. Rogers, Hadson B. Damon.
Transitmen: Principals — C. Barton Pratt, Frank C. Shepherd.
" Assistants — William M. Stodder, Edward I. Marvell.

Trench.

	Largest Sewer.	Two Smaller Sewers.	Smallest Sewer.
Length completed (feet),	2,190.00	3,032.00	1,810.00
Average depth of excavation to bottom of underdrain (feet),	13.80	15.60	12.70
Greatest depth of excavation to bottom of underdrain (feet),	18.80	21.80	19.70
Average width, top of trench (feet),	6.00	6.25	5.20
Average width, bottom of trench (feet),	6.00	6.50	5.20
Volume of excavation per linear foot (cubic yards),	3.07	3.69	2.35
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, backfilling, etc.,	$4 00	$4 60	$4 30

Character of Earth Excavation. — From Western Avenue to corner of DeWolfe and Dyke streets, a distance of about 1,900 feet, 1 foot of loam or gravel, then clay to grade; from thence to about 100 feet east of Boylston Street, gravel, peat and sand, — the peat sometimes running below the springing line of the sewer; for about 150 feet, filling with peat below; from thence for 400 feet to Eliot Square, sand and gravel to grade; for 200 feet, gravel filling with peat below; thence to 100 feet west of Hawthorn Street, sand and gravel; then for 1,100 feet, sand and gravel to within 1 foot from crown of arch, peat below; remainder of the section, 1 foot of sand and gravel, sand and finer gravel below.

Masonry.

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$13 00
Brickwork, Portland cement mortar, per cubic yard,	15 00
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size: —

6 inch,	3,058 feet.
8 inch,	3,967 "

Approximate cost of masonry per linear foot of trench, including underdrain, etc.: —	
Largest sewer and two smaller sewers,	$5 20
Smallest sewer,	5 75
Length of masonry completed: —	
Largest sewer,	2,190 feet.
Two smaller sewers,	3,032 "
Smallest sewer,	1,810 "

Masonry begun June 26, 1893; finished Nov. 2, 1893.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, $9.90.

Note. — The information regarding Section 30 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation.

	Old Opening.	Old Opening.
Character of opening,	Open cut,	Open cut.
Date of starting,	July 3, 1893,	Aug. 22, 1893.
Point of continuing from last year's work.	Nearly opposite entrance to Longfellow Park.	About 200 feet easterly from the corner of Dyke and De Wolfe streets.
Point of ending,	Opposite Lowell Street, corner of Mt. Auburn Street.	Corner Dyke and DeWolfe streets, and also at Eliot Square (worked in two directions).
Date of finishing,	Nov. 2, 1893,	Oct. 26, 1893.
Length,	941 feet,	529 feet.
Ordinary progress per week,	240 feet,	144 feet by trench machine.
Appliances used,	Trench machine,	Part done by trench machine and part by hand.
Gang ordinarily employed,	60 men,	65 men.

A pump-well was made at the corner of Dyke and Plympton streets, in which a 4 inch Webber centrifugal pump was used. There was another pump-well at Mt. Auburn Street, nearly opposite the entrance to Longfellow Park, and in this a 6 inch Webber pump was used. The excavation work was carried on continuously.

Foundation. — The bottom of the trench was composed of peat for a distance of about 1,090 feet on Mt. Auburn Street, from 150 feet west of Hawthorn Street to about 100 feet west of Sparks Street. Here a pile foundation was used. Piles about 10 inches in diameter and 40 feet long were driven in bents 4 feet apart, 2 piles to a bent. On top of the piles 8 inch by 8 inch capping was placed on which a 3 inch platform was laid. The bottom of the trench elsewhere was sand and fine gravel, and the sewer was built in a cradle. The metropolitan sewer passes under local sewers at Eliot and Maynard streets, and over local sewers at Willard and

Sparks streets. At each of the two places last named a cross-section of the metropolitan sewer for a length of 6 feet was changed to 2 foot Akron pipe, with 5 foot reducers at each end. The pipes and reducers were surrounded with concrete. The surplus earth gained by the sewer operations was used for filling on adjacent land.

SECTION 31, CHARLESTOWN.

Location. — In Rutherford Avenue from Cambridge Street to Chapman Street; also from Sullivan Square through Main Street to Beach Street.

Diameters of sewers and length of each size: —

2 feet 5 inches by 3 feet 1 inch,	373 feet.
3 feet 1 inch by 3 feet 8 inches,	2,775 "
2 feet 7 inches by 3 feet 3 inches,	670 "
1 foot 3 inches (vitrified pipe),	660 "

Contractors. — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent. — George W. Judd.

Contractors' Principal Foreman. — Patrick Porter.

State Assistants.

Inspector: Henry M. Woodward.

Transitmen: Principal — Hartley L. White.

" Assistants — Burton A. Clark, Wm. M. Stodder, George E. Howe, George A. Winsor.

Trench and Tunnel.

	2 feet 5 inches by 3 feet 1 inch sewer.	3 feet 1 inch by 3 feet 8 inches sewer.
Length of trench completed (feet),	331.00	1,335.00
Length of tunnel completed (feet),	42.00	30.00
Average depth of trench excavation to bottom of underdrain (feet),	27.40	23.20
Greatest depth of trench excavation to bottom of underdrain (feet),	33.00	24.00
Average width, top of trench (feet),	7.00	7.00
Average width, bottom of trench (feet),	4.75	5.15
Average depth from surface of ground to bottom of tunnel underdrain (feet),	31.80	24.00
Greatest depth from surface of ground to bottom of tunnel underdrain (feet),	33.30	24.00
Average width of tunnel excavation (feet),	4.50	6.00
Volume of trench excavation per linear foot (cubic yards),	5.33	5.17
Volume of tunnel excavation per linear foot (cubic yards),	1.00	1.60
Approximate cost of trench and tunnel per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc.,	$7 00*	$6 45

* With regulator and sump man-hole.

Character of Earth Excavation. — Rutherford Avenue at Cambridge Street: 8 feet of clay and gravel filling, 2½ feet of peaty loam, then gravel, yellow clay and compact sand to grade; at Boston & Lowell Railroad: 8 feet of clay and gravel filling; at Baldwin Street: 2 feet of peat, 9 feet of gravel and sand, 2 feet of fine blue sand, then clayey gravel to grade.

Masonry.

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$12 35
Brickwork, Portland cement mortar, per cubic yard,	14 25
Concrete, American cement mortar, per cubic yard,	6 86
Concrete, Portland cement mortar, per cubic yard,	7 86

Diameters of underdrain laid and length of each size: —

8 inch,	1,120 feet.
10 inch,	580 "

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, etc.: —

2 feet 5 inches by 3 feet 1 inch sewer,	$5 80
3 feet 1 inch by 3 feet 8 inches sewer,	6 45

Length completed, trench,	1,578 feet.
Length completed, tunnel,	72 "

Masonry was begun June 12, 1894, and is now (September 30) in progress.

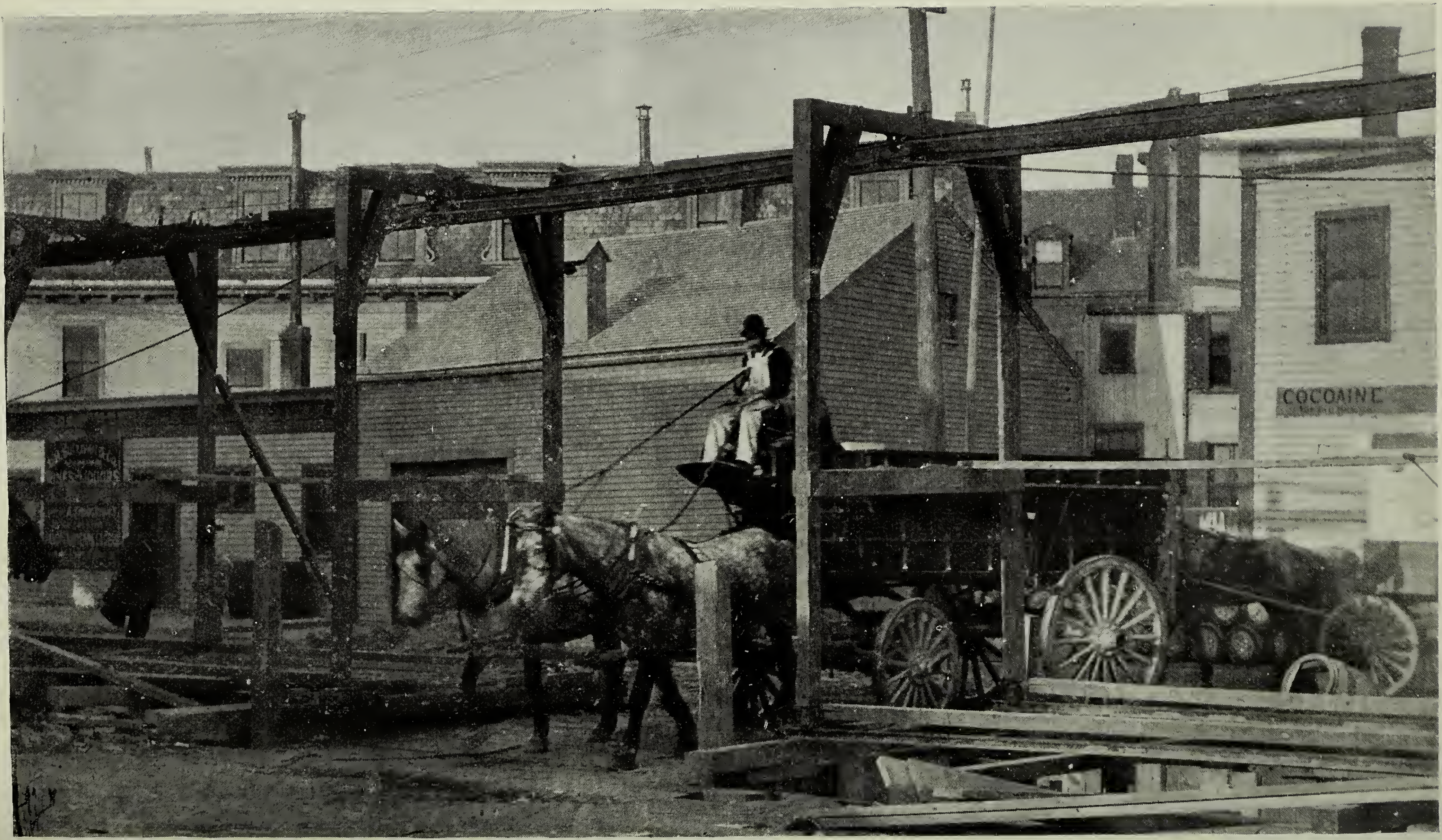
Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (September 30), $12.50.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening,	Open cut,	Tunnel,	Tunnel.
Number of tunnel headings.	-	One,	One.
Date of starting,	May 25, 1894,	June 29, 1894,	July 18, 1894.
Point of beginning,	Junction of Rutherford Avenue and Cambridge Street.	Junction of Rutherford Avenue and Cambridge Street (southerly side of West End R.R.).	Rutherford Avenue, northerly side of Boston & Lowell R.R.
Point of ending,	-	42 feet north of point of beginning, joining bell-mouth, Section 26.	Rutherford Avenue, southerly side of Boston & Lowell R.R.
Point where work is now going on.	In Rutherford Avenue, 50 feet north of Middlesex Street.	-	-
Date of finishing,	In progress Sept. 30,	July 19, 1894,	July 26, 1894.
Length,	1,648 feet,	42 feet,	30 feet.
Ordinary progress per week.	126 feet,	20 feet,	30 feet.
Appliances used,	Trench machine,	"A Frame" derrick,	Hoisting apparatus of trench machine.
Gang ordinarily employed.	45 men,	4 men,	6 men.

The pumping for the first 1,100 feet of this section was done by a 4 inch pulsometer at Sullivan Square, and for the remainder of the work it was done by a 6 inch centrifugal Lawrence pump at a well on Rutherford Avenue 200 feet north of Baldwin Street.

Foundation. — The bottom of the trench consisted of clay and gravel for about 400 feet from Cambridge Street to the Boston &



Section 31, Charlestown. Temporary Bridge to Freight Sheds, over the Trench on Rutherford Avenue between Mill and Middlesex Streets.

Lowell Railroad, and also for about 120 feet on Rutherford Avenue southerly from a point about 150 feet south of the Boston & Lowell Railroad. The bottom of the trench at these places was excavated to fit the invert of the sewer. The bottom of the tunnel excavated under the Boston & Lowell Freight Railroad was a stratum 2 feet deep of fine running sand, and here 3 inch tongued and grooved sheeting was used to prevent running of the sand and settlement of the roof. On Rutherford Avenue from the Boston & Lowell Railroad to Essex Street the bottom of the trench was clayey gravel and fine running sand, with the exception of 120 feet, where it was clay and gravel, as already mentioned. The clayey gravel and fine running sand was replaced to the top of the underdrain with about 4 inches of gravel.

Miscellaneous. — At the tunnel under the Boston & Lowell Freight Railroad the back-filling over the arch for a length of 21 feet was Portland brick masonry, and for 9 feet was American concrete masonry. The curbing and sidewalk for the entire extent of the trench settled from 2 to 6 inches. The contractors had their choice, subject to the chief engineer's approval, of going in Rutherford Avenue either in the street or under the west curbing. The contractors built the centre of sewer 6 feet into the street from the west curbing. The advantages supposed to be gained by this were that the metropolitan sewer would be a safe distance from the old local brick sewer already in the street, would avoid the old catch-basins, and would also save moving the curbing on the west side of the street. Part of the surplus material from the trench has been used for filling on low land belonging to the Boston & Maine Railroad west of Rutherford Avenue, and the remainder has been used for filling at Tufts' Mill Pond.

SECTION 32 (CONTRACT WORK), CHARLESTOWN.

Location. — From Chapman Street at Rutherford Avenue, through private land by tunnel to Front Street, through Front and Water streets to the Navy Yard at Wapping Street. Work done directly by the State intervenes from here to Chelsea Street opposite Vine Street, whence the contract work continues in Chelsea Street to Medford Street.

Diameters of sewers and length of each size: —

2 feet 7 inches by 3 feet 3 inches,	869 feet.
2 feet 5 inches by 3 feet 1 inch,	1,606 "
2 feet 3 inches by 3 feet,	608 "
2 feet 1 inch by 2 feet 10 inches,	677 "
1 foot 7 inches by 2 feet 4 inches,	942 "

Contractors. — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent. — George W. Judd.

Contractors' Principal Foreman. — P. Percello.

State Assistants.

Inspectors: John D. Collins, Edward A. Clark.
Transitmen: Principal — C. Barton Pratt.
" Assistants — Edward I. Marvell, Thomas H. Wiggin, George F. Clark.

Trench and Tunnel.

	2 feet 7 inches by 3 feet 3 inches sewer.	2 feet 5 inches by 3 feet 1 inch and 2 feet 3 inches by 3 feet sewers.	2 feet 1 inch by 2 feet 10 inches sewer.
Length completed of trench excavation (feet),	-	2,141.00	23.00
Length completed of tunnel excavation (feet),	688.00	73.00	-
Average depth of trench excavation to bottom of underdrain (feet),	-	19.11	16.80
Greatest depth of trench excavation to bottom of underdrain (feet),	-	20.60	16.80
Average width, top of trench (feet),	-	6.21	5.50
Average width, bottom of trench (feet),	-	4.82	4.40
Average depth from surface of ground to bottom of tunnel underdrain (feet),	29.50	19.60	-
Greatest depth from surface of ground to bottom of tunnel underdrain (feet),	38.40	19.80	-
Average width of tunnel excavation (feet),	4.00	4.00	-
Volume of trench excavation per linear foot (cubic yards),	-	3.75	2.92
Volume of tunnel excavation per linear foot (cubic yards),	0.88	0.71	-
Approximate cost of trench per linear foot, including sheeting left in, back-filling, etc., to date (September 30),	-	$5 80	$5 08
Approximate cost of tunnel excavation per linear foot, including lumber left in, back-filling, etc., to date (September 30),	$5 95	4 65	-

Character of Earth Excavation. — Front Street near beginning of trench: paving, then sand and gravel for 6½ feet, peat, silt and shells to 1 foot above springing line of sewer, then blue clay mingled with sand and gravel; about opposite Arrow Street: hard blue clay took the place of sandy clay; Front Street, between Arrow and Walford streets: paving, sand, gravel and clay to 9 feet below surface, 4 feet of peat, hard blue clay to grade; opposite the easterly end of the Boston & Maine Railroad freight station: hard yellow clay took the place of the blue clay; Warren Avenue: paving, 13 feet of sand and gravel, yellow clay to grade; Water Street, near Chambers Street: paving, 7 feet sand and gravel filling, sandy clay, fine sand to grade; Hudson Street and further: paving, 8 feet of sand and gravel, 1½ feet of peaty fibrous material, 1 foot of sand and peat, hard yellow clay to grade.

Masonry.

Contract price: —

Brickwork, American cement mortar, per cubic yard, trench,	$12 35
Brickwork, American cement mortar, per cubic yard, tunnel,	15 08
Brickwork, Portland cement mortar, per cubic yard, trench,	14 45
Brickwork, Portland cement mortar, per cubic yard, tunnel,	17 08
Concrete, American cement mortar, per cubic yard,	5 86
Concrete, Portland cement mortar, per cubic yard, trench,	7 86
Concrete, Portland cement mortar, per cubic yard, tunnel,	9 25

Diameters of underdrain laid and length of each size: —

6 inch,	629 feet.
8 inch,	2,144 "
10 inch,	102 "

Approximate cost of masonry per linear foot of excavation, including underdrain, etc.: —

2 feet 5 inches by 3 feet 1 inch and 2 feet 3 inches by 3 feet sewer, in trench,	$4 30
2 feet 1 inch by 2 feet 10 inches sewer, in trench,	1 67
2 feet 7 inches by 3 feet 3 inches sewer, in tunnel,	5 43

Length of masonry completed: —

2 feet 5 inches by 3 feet 1 inch and 2 feet 3 inches by 3 feet sewer, in trench,	2,214 feet.
2 feet 1 inch by 2 feet 10 inches sewer, in trench,	23 "
2 feet 3 inches by 3 feet 3 inches sewer, in tunnel,	606 "

Masonry was begun in trench June 8, 1894, and is now (September 30) in progress.

Masonry was begun in tunnel June 6, 1894, and is now (September 30) in progress.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items to date (September 30), $10.60.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.	Opening No. 5.
Character of opening.	Tunnel,	Open cut,	Tunnel,	Open cut,	Tunnel.
Number of tunnel headings.	Two,	-	Two,	-	Two.
Date of starting,	May 23, 1894,	June 4, 1894,	July 26, 1894,	Aug. 18, 1894,	Aug. 23, 1894.
Point of beginning,	Austin Street,	Front Street, about 30 feet west of Fifth Street, produced.	Lynde Street,	City Square,	Each side of Warren Avenue.
Point of ending,	About 60 feet easterly from Chapman Street. Also under Washington Street.	Corner Front Street and Warren Avenue.	Under Washington Street. Also at Front Street.	Water Street, near Gray Street.	Centre of Warren Avenue, where the two tunnel headings met.
Date of finishing,	July 26, 1894,	Aug. 18, 1894,	In progress September 30,	In progress September 30,	Sept. 6, 1894.
Length,	339 feet,	1,483 feet,	349 feet,	694 feet,	73 feet.
Ordinary progress per week.	42 feet,	144 feet,	44 feet,	96 feet,	30 feet.
Appliances used,	Incline,	Trench machine,	Incline,	Trench machine,	Tripod derrick.
Gang ordinarily employed.	8 men,	32 men,	8 men,	32 men,	6 men.

Pumping for the whole of the open cut was done by a 6 inch Webber centrifugal pump on Front Street. A 2 inch Blake pump was used at each of the tunnel shafts — Austin Street and Lynde Street — for removing water from those tunnels.

Foundation. — Sandy yellow clay was found in the bottom of the trench for a distance of 811 feet in Front Street from about opposite Arrow Street to about 50 feet east of Jenner Street, and also for a distance of 465 feet from near the west side of Warren Avenue through Water Street. In these places the bottom of the trench was excavated to fit the invert of the sewer. Elsewhere the bottom of the excavation was clayey sand and gravel. Concrete was placed between this and the brickwork for a foundation.

Difficulties. — The metropolitan sewer was built under several local sewers from the corner of Warren Avenue and Front Street along Water Street. The sewer was built by tunnelling for a length of 73 feet under Warren Avenue, in order to avoid disturbing the street railway tracks. The arch of the tunnel for the lower half of this length was back-filled with solid brickwork, and the remainder of the arch was back-filled with concrete. On Front Street near Warren Avenue an old stone pier was encountered. This brought in water at every high tide, flooding the trench. The tide was shut out by building a concrete collar on the arch of the sewer, and packing the side of the trench with concrete. After these measures were taken the work was carried on at a satisfactory rate.

Along Front Street for about 1,000 feet, where the Boston & Maine freight depot is located on one side of the street and the Fitchburg Railroad freight depot on the other, the street is crowded with teams during a large portion of the day, and some fears were expressed that the sewer could not be constructed through this portion of the street without seriously interfering with the traffic to and from the depots. To avoid this, the work of construction was continued day and night and the opening in the street, back of the trench machine, was back-filled and the surface repaved as soon as possible. The work of repaving had to be done over or repaired several times, as the earth which had been disturbed gradually settled back into place again. Every precaution which was practicable was taken not to discommode the public, and, in consequence, the work caused very little delay or inconvenience to the teams handling freight at the depots or to teams passing through the street.

Miscellaneous. — A portion of the outside track of the Fitchburg Railroad could not be used from July 13 to August 18, while the trench machine was on Front Street just west of Jenner Street, and about 300 feet from Warren Avenue. At the end of that time the sewer had been built to Warren Avenue. There was no delay to railroad traffic, as the company was able to take care of it all on their other tracks. Some of the surplus earth gained by the sewer operations has been used for filling on low land of the Boston & Maine Railroad near Rutherford Avenue. Some of the surplus earth has also been carted to Chelsea bridge.

SECTION 32 (DAY WORK), CHARLESTOWN NAVY YARD.

Location. — From just outside the Wapping Street entrance to the Navy Yard to about 20 feet inside of the gates, by tunnel; by open cut for 150 feet parallel to the storehouse; thence through Gun Park and Shot Park and between the muster house and sail loft; thence parallel to the rope-walk for a distance of about 250 feet; and then turning to the left under the rope-walk by tunnel to Chelsea Street nearly opposite Vine Street.

Diameters of sewers and length of each size: —

2 feet 1 inch by 2 feet 10 inches,	1,092 feet.
1 foot 10 inches by 2 feet 7 inches,	453 "
1 foot 7 inches by 2 feet 4 inches,	30 "

Assistants.

Foreman: George F. Greenlaw.
Transitmen: Principal — C. Barton Pratt.
" Assistants — Edward I. Marvell, Thomas H. Wiggin, George F. Clark.

Trench and Tunnel.

	2 feet 1 inch by 2 feet 10 inches sewer.
Length completed of trench excavation,	657.00 feet.
Length completed of tunnel excavation,	41.00 "
Average depth of trench excavation to bottom of underdrain,	19.20 "
Greatest depth of trench excavation to bottom of underdrain,	21.50 "
Average width, top of trench,	5.50 "
Average width, bottom of trench,	4.50 "
Depth from surface of ground to bottom of tunnel underdrain,	16.80 "
Average width of tunnel excavation,	3.30 "
Volume of trench excavation per linear foot,	3.34 cu. yds.
Volume of tunnel excavation per linear foot,	0.59 "

Approximate cost of trench per linear foot, including sheeting left in, back-filling, etc., to date (September 30), $11.

Approximate cost of tunnel excavation per linear foot, including lumber left in, etc., $3.70.

Character of Earth Excavation. — Just inside the Wapping Street entrance to Navy Yard: 4 inches asphalt paving, 2 inches sand, 4 inches concrete, 4 inches sand, about 5½ feet of sand and gravel, clay to grade; just before entering Gun Park: paving, sand and gravel to 10 feet below surface, coarse gravel to grade; after entering Gun Park: 2 feet of loam, yellow sandy clay to grade; about the middle of the Gun Park: loam, fine sand and clay, then sand, gravel and yellow clay; entrance to Shot Park: loam, hard sandy clay to grade.

Masonry.

Diameters of underdrain laid and length of each size: —

6 inch,	262 feet.
8 inch,	425 "

Length of masonry completed: —

Masonry in trench,	619 "
Masonry in tunnel,	41 "

Masonry was begun in trench July 19, 1894, and is now (September 30) in progress.

Masonry begun in tunnel Aug. 1, 1894; finished Aug. 25, 1894.

Approximate cost of section per linear foot of excavation and masonry, including labor, material and miscellaneous items, to date (September 30), $14.40.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Tunnel.
Number of tunnel headings,	- -	One.
Date of starting,	July 12, 1894,	July 28, 1894.
Point of beginning,	Just inside the Wapping Street entrance to Navy Yard.	Just inside the Wapping Street entrance to Navy Yard.
Point of ending,	In progress in middle of Shot Park.	About 17 feet outside of Navy Yard.
Date of finishing,	In progress Sept. 30,	Aug. 27, 1894.
Length,	657 feet,	41 feet.
Ordinary progress per week,	72 feet,	30 feet.
Appliances used,	Trench machine,	Tripod with one bucket. Bucket hoisted by horse power.
Gang ordinarily employed,	50 men,	5 men.

A No. 5 pulsometer was used at a well just outside of Gun Park.

Foundation. — At places as follows the bottom of the excavation has been clay and sandy clay, which has been excavated to fit the invert of the sewer: from the beginning of the work to within about 75 feet of the Gun Park, a distance of about 205 feet, and for a further length of 262 feet, from 54 feet beyond the first-mentioned place to the middle of the Gun Park. For this intervening space of 54 feet the bottom of the excavation was coarse gravel. The sewer was here built in a cradle. From the middle of the Gun Park to the Middle of the Shot Park the bottom of the excavation has been sandy clay, and the sewer has here been built with a concrete foundation.

Miscellaneous. — In building the sewer through the Gun Park, construction had to be carried on between rows of guns whose positions allowed but a limited space for the operations. Several piles of shot and shell, together with the masonry foundation on which they rested, had to be removed in going through the Shot

Park. At the tunnel at the beginning of the work the arch of the sewer was back-filled with concrete, on account of the metropolitan sewer going under a local brick sewer diagonally. The surplus earth from the excavation has been used to fill in low land on Medford Street.

Section 35, Charlestown, Somerville and Medford.

Location. — From Alford Street at Arlington Avenue, Charlestown, through Arlington Avenue, across the Grand Junction and Boston & Maine Railroad tracks and through Mousal Place to North Union Street; thence through private land to Mystic Avenue near Austin Street, and through Mystic Avenue to a point in Medford a few feet beyond the Somerville and Medford line.

Diameters of sewers and length of each size: —

3 feet 4 inches by 4 feet 1 inch,	920 feet.
3 feet 3 inches by 3 feet 11 inches,	2,462 "
2 feet 11 inches by 3 feet 7 inches,	697 "
1 foot 10 inches by 2 feet 3 inches,	4,291 "

Contractors. — James Heath & Son of Lynn, Mass.

Contractors' Superintendent. — John Heath, a member of the above-mentioned firm.

State Assistants.

Inspectors: M. F. Garra, Caleb Kimball, B. L. Sykes, Paul W. Rowell, John D. Collins, Burton A. Clark.

Transitmen: Principals — Paul W. Rowell, Hartley L. White.

" Assistants — Wm. M. Stodder, George E. Howe, Arthur H. Pratt, Burton A. Clark, George A. Winsor, Harry L. Ward.

Trench and Tunnel.

	Two Largest Sewers.	Smallest Sewer.
Length of trench completed (feet),	239.00	1,337.00
Length of tunnel completed (feet),	2,112.00	-
Average depth of trench excavation to bottom of underdrain (feet),	29.00	21.50
Greatest depth of trench excavation to bottom of underdrain (feet),	30.00	23.00
Average width, top of trench (feet),	7.50	4.50
Average width, bottom of trench (feet),	6.10	4.20
Average depth from surface of ground to bottom of tunnel underdrain (feet),	28.00	-
Greatest depth from surface of ground to bottom of tunnel underdrain (feet),	34.50	-
Average width of tunnel excavation (feet),	5.50	-
Volume of trench excavation per linear foot (cubic yards),	7.00	3.30
Volume of tunnel excavation per linear foot (cubic yards),	1.50	-
Approximate cost of trench per linear foot, including sheeting left in, back-filling, etc , to date (September 30),	$6 45	$2 80
Approximate cost of tunnel excavation per linear foot, including sheeting left in, back-filling, etc., to date (September 30),	6 35	-

Character of Earth Excavation. — In Arlington Avenue: 1 foot of quarry chips, 3 feet of gravel filling, clay to bottom of excavation; at North Union Street for a length of 200 feet: compact gravelly clay; in Mystic Avenue: 1 foot of quarry chips, clay to bottom of excavation; opposite Broadway Park: 5 feet of broken stone filling, 8 feet of peat, clay below; opposite Temple Street: 1 foot of quarry chips, 10 feet of clay, ledge below.

Masonry.

Contract price: —	
Brickwork, American cement mortar, per cubic yard,	$14 00
Brickwork, Portland cement mortar, per cubic yard,	15 00
Concrete, American cement mortar, per cubic yard,	6 00
Concrete, Portland cement mortar, per cubic yard,	7 00
Diameters of underdrain laid and length of each size: —	
4 inch,	712 feet.
6 inch,	1,107 "
Approximate cost of masonry per linear foot of excavation, including underdrain, etc., to date (September 30): —	
3 feet 3 inches by 3 feet 11 inches sewer, trench,	$5 25
1 foot 10 inches by 2 feet 3 inches sewer, trench,	2 10
3 feet 4 inches by 4 feet 1 inch and 3 feet 3 inches by 3 feet 11 inches sewers, tunnel,	5 50
Length of masonry completed: —	
3 feet 3 inches by 3 feet 11 inches sewer, trench,	214 feet.
1 foot 10 inches by 2 feet 3 inches sewer, trench,	1,236 "
Sewer masonry, tunnel,	1,680 "

Masonry was begun in tunnel June 20, 1894, and is now (September 30) in progress.

Masonry was begun in trench July 16, 1894, and is now (September 30) in progress.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (September 30): —	
Two largest sewers, trench and tunnel,	$12 35
Smallest sewer, trench,	5 15

Excavation and Tunnel Methods. — A tunnel shaft was started May 24 in Arlington Avenue, about 200 feet from the beginning of the section. From this point to Mystic Avenue shafts were sunk at each man-hole at distances of about 250 feet apart. The tunnelling from these shafts has aggregated about 1,526 feet. July 18 two shafts were sunk in Mystic Avenue; one opposite Middlesex Avenue, and another about 200 feet southerly from there. The aggregate length of the tunnelling done here has been about 604 feet. Work is now (September 30) in progress in both of these tunnels. The bottom of the tunnel excavation in clay was excavated to fit the invert of the brick masonry. The work in each tunnel heading has ordinarily been carried on in two shifts, eight men to a shift. The average progress per week at each heading has been about 9 feet. In addition to the tunnels, there have been 2 open cuts. One open cut was started June 12, at a point about 200 feet north of Austin Street in Mystic Avenue, and operations in this have extended northerly for about 240 feet, and are now in progress. The ordinary progress per week has been about 50 feet. The gang employed has usually consisted of 35 men. The other open cut was started July 16 in Mystic Avenue opposite Winthrop Avenue. Work on this is still in progress, and operations have extended a distance of about 1,340 feet to near Temple Street. The ordinary progress per week has been 120 feet, with the same sized gang as on the other open cut. "A frame" steam derricks have been used on all but one of the tunnel shafts. On this a tripod derrick was operated by horse power. Trench machines have been used on the open cut. Water in the tunnel has been usually hoisted out in the large buckets for removing excavated material. At one tunnel heading on Mystic Avenue a 1 inch ejector was used. Hand pumps were used in the trench. The tunnelling was carried on by the ordinary timber method. Sets of caps and legs were placed about 5 feet apart on centres. Skeleton lagging was used in many places, where the clay was firm and stood well. Usually one engine did the hoisting for two tunnel shafts. This has been done by leading one rope through a foot block and over rollers on the ground to the next shaft.

Foundation. — The bottom of the trench has been clay, which has been excavated to fit the brick invert of the sewer, for a distance of about 214 feet in Mystic Avenue near Austin Street, and for a distance of about 500 feet in the same avenue from Wheatland to Taylor streets. In Mystic Avenue opposite Broadway Park the bottom of the trench was sandy clay, upon which American concrete foundation was built. The bottom of the tunnel excavation was clay.

Miscellaneous. — Some of the surplus earth has been placed on adjacent low land. Some of the clay surplus gained in Mystic Avenue was used to make brick in one of the neighboring brickyards.

SECTION 36, EAST BOSTON.

Location. — From a point in Chelsea Street about opposite the centre of Eagle Square, across Eagle Square to East Eagle Street.

Diameter of sewer and length: —

1 foot 3 inches (vitrified pipe), ...	237 feet.

Contractors. — National Construction Company of Boston, Mass.

Contractors' Superintendent. — Michael Tallent.

Contractors' Principal Foreman. — Fred E. Dennen.

State Assistants.

The State assistants here were from near-by contract sections.

Trench and Pipe.

Length of trench completed,	237.00 feet.
Length of pipe laid,	237.00 "
Average depth of excavation to bottom of sewer pipe,	18.50 "
Greatest depth of excavation to bottom of sewer pipe,	26.00 "
Average width, top of trench,	2.50 "
Average width, bottom of trench,	2.50 "
Volume of excavation per linear foot of trench,	1.70 cu. yds.

Pipe work begun August 31; finished Sept. 21, 1894.

Character of Earth Excavation. — About 1 foot of crushed stone for nearly half the section and gravel for the balance; below was clay, with which was mingled a little gravel.

Masonry (Man-holes).

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$13 00
Brickwork and granite work, Portland cement mortar, per cubic yard,	21 00
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	6 00

Number of man-holes built, 2.

Approximate cost per man-hole, $127.50.

Approximate cost of section per linear foot of trench and pipe (with man-holes), including labor, material, inspection, and miscellaneous items, $5.10.

The excavating was done by open cut, from which the earth was thrown by hand. Digging began Aug. 25, 1894, at the beginning of the section, at a point in Chelsea Street about opposite the centre of Eagle Square, and ended Sept. 29, 1894, at the end of the section, at East Eagle Street. The gang ordinarily employed consisted of 15 men. Excavation progressed at the rate of 59 feet per day. The only water encountered was for a few feet next to the Section 37 sewer, where some had collected in the tunnel drift of that section. The bottom of the trench was composed of clay, which for almost the entire length was of such quality that it was excavated to fit the invert of the sewer pipe. The surplus earth was mounded over the trench.

SECTION 37, EAST BOSTON.

Location. — From a point in Chelsea Street, about 200 feet from Chelsea Creek bridge, to Prescott Street, and in that and Bremen Street to a point about 300 feet beyond Brooks Street.

Diameters of sewers and length of each size: —

3 feet 4 inches by 3 feet 9 inches,	467 feet.
3 feet by 3 feet 5 inches,	4,396 "
Bell-mouths,	19 "

Contractor. — John Sheehan of Lynn, Mass.

Contractor's Principal Foremen (Year ending Sept. 30, 1894). — Trench: Jeremiah Barry. Tunnel: J. N. Reesby, Peter Hill.

State Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Seth Peterson.
Inspector: J. J. Conway.
Transitmen: Principals — George R. Winslow, Thomas T. Cass.
" Assistants — Thomas T. Cass, George F. Clark, Rolfe M. Ellis.

Trench and Tunnel.

	Larger Sewer.	Smaller Sewer.
Length completed of trench excavation (feet),	288.00	1,771.00
Length completed of tunnel excavation (feet),	179.00	2,559.00
Average depth of trench excavation to bottom of underdrain (feet),	30.00	26.50
Greatest depth of trench excavation to bottom of underdrain (feet),	31.00	33.00
Average width, top of trench (feet),	8.00	8.00
Average width, bottom of trench (feet),	6.80	5.60
Average depth from surface of ground to bottom of tunnel underdrain (feet),	30.00	31.00
Greatest depth from surface of ground to bottom of tunnel underdrain (feet),	31.00	34.00
Average width of tunnel excavation (feet),	4.70	5.00
Volume of trench excavation per linear foot (cubic yards),	8.30	7.00
Volume of tunnel excavation per linear foot (cubic yards),	1.20	1.40
Approximate cost of trench per linear foot, including sheeting left in, back-filling, etc., to date (September 30),	$6 65	$6 75
Approximate cost of tunnel excavation per linear foot, including timber left in, etc., to date (September 30),	6 25	5 50

Character of Earth Excavation. — Beginning of section to corner of Prescott and Bremen streets: excavation was by tunnel through clay, with the exception that for about 700 feet at Curtis Street the excavation was by open cut, in which there was sand and gravel to grade; in Bremen Street south of Prescott Street: the clay gradually went lower, and instead, fine, wet sand with traces of clay was found; at Putnam Street: 9½ feet filling of mingled clay and gravel, 5 feet of peat, 2 feet of sand, clay below; at Brooks Street: 9 feet of filling of mingled clay and gravel, 6 feet of peat, sand below.

Masonry.

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$12 90
Brickwork, Portland cement mortar, per cubic yard,	15 00
Concrete, American cement mortar, per cubic yard,	5 50
Concrete, Portland cement mortar, per cubic yard,	6 50

Diameters of underdrain laid and length of each size: —

6 inch,	2,577 feet.
8 inch,	1,388 "
10 inch,	107 "
12 inch,	212 "

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, etc., to date (September 30), $5.20.

Length of masonry completed: —

Trench (including bell-mouths),	2,057 feet.
Tunnel,	2,738 "

Masonry was begun in tunnel March 27, 1893, and is now (September 30) in progress.

Masonry was begun in trench July 27, 1893, and is now (September 30) in progress.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items to date (September 30), $11.70.

NOTE. — The information regarding Section 37 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation.

	Old Opening.	Old Opening.	New Opening.	New Opening.	New Opening.	New Opening.	New Opening.
Character of opening,	Open cut, . .	Tunnel, . . .	Tunnel, . . .	Tunnel, . . .	Tunnel, . . .	Tunnel, . . .	Open cut.
Number of tunnel headings.	-	Two, ...	Two, . . .	Two, . . .	Two, . . .	Two, ...	-
Date of starting, .	July 7, 1893, . .	Sept. 16, 1893, . .	Nov. 1, 1893, . .	Dec. 7, 1893, . .	Dec. 11, 1893, . .	Jan. 24, 1894, . .	Feb. 28, 1894.
Point of beginning, .	-	-	Shaft opposite Shelby Street.	Shaft just north of Bennington Street.	About 100 feet south of Bennington Street.	Corner Prescott and Bremen streets.	Corner of Prescott and Bremen streets.
Point of continuing from last year's work.	About 130 feet north of Curtis Street.	Just north of Saratoga Street.	-	-	-	-	-
Point of ending, .	283 feet north of Curtis Street.	About 100 feet north of Saratoga Street, and about the middle of Saratoga Street.	140 feet north and 150 feet south of Shelby Street.	160 feet north of shaft and 197 feet south of shaft.	About on south line of Bennington Street, and also at corner of Prescott and Chelsea streets.	Corner of Prescott and Chelsea streets, and also 20 feet from shaft in Bremen street.*	In progress 25 feet south of Brooks Street.
Date of finishing, .	Oct. 30, 1893, . .	Nov. 7, 1893, . .	Dec. 7, 1893, . .	Jan. 29, 1894, . .	Jan. 29, 1894, . .	March 1, 1894, . .	In progress Sept. 30, 1894.
Length, . . .	157 feet, . . .	246 feet, . . .	290 feet, . . .	357 feet, . . .	290 feet, . . .	243 feet, . . .	1,436 feet.
Ordinary progress per week.	40 feet, . . .	45 feet in each heading.	94 feet, . . .	70 feet, . . .	70 feet, . . .	55 feet in first mentioned heading.	96 feet.
Appliances used, .	Trench machine, .	Wheelbarrows, derrick at shaft.	Wheelbarrows, derrick at shaft.	Wheelbarrows, derrick at shaft.	Derrick, . . .	Derrick, . . .	Trench machine.
Gang ordinarily employed in excavation.	30 men, . . .	20 men, . . .	20 men, . . .	20 men, . . .	20 men, . . .	20 men, . . .	30 men.

* This latter heading settled, and was changed to open cut. It is a part of that described in the column to the right.

The ground water in the open cuts was handled by a 6 inch centrifugal pump. This was employed at the following points: about 300 feet south of Curtis Street, about 150 feet south of Prescott Street on Bremen Street, and at a point about 150 feet south of Putnam Street. In the tunnel-shafts pulsometers were used, but there was very little more water than could have been removed with hand pumps. There have been several shut downs, each lasting three or four days. The alleged cause was tardiness in paying wages. The work is now (September 30) stopped, partly on account of the trench on Bremen Street near Brooks Street being flooded by tide water, and probably partly on account of the contractor's financial embarrassment.

Foundation. — The bottom of the excavation was made to fit the invert of the sewer as follows: from the beginning of the section to the corner of Prescott and Bremen streets (with the exception of about 700 feet near Curtis Street, about 100 feet in Eagle Square and about 73 feet near Bennington Street), and for about 90 feet in Bremen Street between Prescott and Putnam streets. Where the bottom of the excavation was made to fit the invert of the sewer the material was clay, mixed in some cases with gravel or sand. Referring to the exceptions given above, the bottom of the excavation for the 700 foot length near Curtis Street was of comparatively unstable sand and gravel, upon which was placed a concrete foundation. At the other exceptions, and for nearly the whole length of Bremen Street, the bottom of the excavation was wet sand and clay. This was removed to an average depth of about 8 inches below the bottom of the masonry, and replaced by well-compacted gravel.

Difficulties. — About 100 feet of the tunnel drift in Eagle Square, 73 feet in Bennington Street and 150 feet in Bremen Street, settled badly on account of water being allowed to rise in the excavation and soften the sand about the foot-plates. At Eagle Square and Bennington Street nearly all of the tunnel drift was driven a second time before any masonry whatever was put in. When the masonry was put in, it was thought prudent to make it heavier than usual, in consequence of this settlement. In some places the space to the lagging was filled, while in other places, where the settlement was not so great, only 6 inches or so of concrete was added. Near the end of the section, or about 250 feet south of Brooks Street, the city sewer outlet, 4 feet by 4 feet, crosses the line of the metropolitan sewer. The contractor has attempted to tunnel under this, but has so far been unsuccessful on account of the large amount of tide water coming through and around the old outlet.

Accidents. — Bartholomew Burke was badly injured January 13 by falling from a mast while he was taking down a derrick.

Miscellaneous. — The surplus earth gained by the sewer operations has been used in filling adjacent low land.

SECTION 37½ (DAY WORK), EAST BOSTON.

Location. — From a man-hole about 200 feet south of Old Chelsea bridge on Chelsea Street, and running in an easterly direction to pumping station.

Diameters of sewers and length of each size: —

3 feet 4 inches by 3 feet 9 inches sewer (tunnel),	255 feet.
Regulator and sump,	21 "

Assistants.

Assistant Engineer: Henry H Marden, Jr.
Principal Foreman: Daniel Hogan.
Transitman: Charles Kincaid.

Excavation.

Length of tunnel completed,	255 00 feet.
Depth from surface of ground to bottom of tunnel masonry,	28.00 "
Average width of tunnel excavation,	5.00 "
Volume of tunnel excavation per linear foot,	1.33 cu. yds.

Total cubic yards of excavation for sump and regulator, 350.

Approximate cost of tunnel excavation per linear foot, $7.25.

Approximate cost of excavation for sump and regulator per cubic yard, $2.05.

Character of Earth Excavation. — Compact clay and stones.

Masonry.

Length of tunnel masonry completed,	255 feet.
Volume of masonry for sump and regulator: —	
Concrete, Portland cement mortar,	18 cubic yards.
Brickwork, Portland cement mortar,	26 " "

Approximate cost of tunnel masonry per linear foot,	$8 25
Approximate cost of masonry for sump and regulator, per cubic yard: —	
Concrete,	8 25
Brickwork,	18 50

Masonry begun in tunnel June 29, 1894; finished in tunnel Aug. 9, 1894; regulator, etc., finished Sept. 21, 1894.

Approximate cost of section per linear foot of excavation and masonry, including labor, material and miscellaneous items, $19.40.

Construction. — A shaft was started May 7, 1894. This extended lengthwise of the section easterly for 23 feet from a point about 43 feet easterly from the beginning of the section, and had a width of 12 feet. It was sunk to a depth of 30 feet. The bottom was reached May 25. Later a regulator and sump were built in this excavation, but its first use was as a base of operations for two tunnel headings. The easterly heading was begun May 25, and on June 28 the drift had been carried for about 210 feet to the end of the section. The westerly heading was also begun May 25, and this drift worked back to the beginning of the section, a distance of 43 feet. This westerly drift was finished August 1. It was not worked continuously, but was held in reserve as a place from which to get back-filling for use in the easterly heading, and also to provide a place for the men to work when the easterly heading was not in condition to employ the whole gang to advantage. The ordinary progress of excavation per week in the easterly heading was about 50 feet. An incline was used for hoisting out the excavated material. Twelve men ordinarily worked in sinking the shaft. In each tunnel heading the excavation was carried on in two shifts per twenty-four hours, 6 men in each shift. The surplus material gained in excavation was used for filling on the metropolitan sewerage stock-yard lot.

Clay and stones were found in the bottom of all this excavation. The bottom was excavated to fit the invert of the sewer.

Some difficulty with water was experienced while connecting the masonry with that of Section 37.

SECTION 38, EAST BOSTON.

Location. — From a point in Bremen Street, about 300 feet south of Brooks Street through Bremen, Decatur, Orleans, Maverick and Jeffries streets to Sumner Street; also a branch from corner of Maverick and Orleans streets, through Orleans and Marginal streets to about 800 feet beyond Cottage Street.

Diameters of sewers and length of each size: —

3 feet by 3 feet 5 inches,	1,025 feet.
2 feet circular (vitrified pipe),	46 "
1 foot 6 inches (vitrified pipe),	1,519 "
1 foot 3 inches (vitrified pipe),	4,307 "
1 foot (vitrified pipe),	1,332 "

Contractors. — James Heath & Son of Lynn, Mass. Mr. James Heath has acted as his own superintendent.

Contractors' Principal Foremen. — Michael Stapleton, Peter Dolan.

State Assistants.

Assistant Engineer: Seth Peterson.
Inspectors: George A. Chase, L. M. S. Horton.
Transitmen: Principal — Thomas T. Cass.
" Assistants — George F. Clark, Rolfe M. Ellis, David H. Winslow.

Trench.

	3 Feet by 3 Feet 5 Inches Sewer.	2 Feet Pipe Sewer.	1 Foot 6 Inches Pipe Sewer.	15 Inch Pipe Sewer.
Length completed (feet),	1,025.00	46.00	923.00	87.00
Average depth of excavation to bottom of gravel refilling (feet),	24.00	21.00	20.00	18.00
Greatest depth of excavation to bottom of gravel refilling (feet),	25.00	21.00	25.00	19.50
Average width, top of trench (feet),	7.10	5.20	5.00	4.30
Average width, bottom of trench (feet),	5.50	4.60	4.40	3.50
Volume of excavation per linear foot (cubic yards),	5.80	3.90	3.60	2.80
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1894),	$6.30	*$7.10†	$4.50†	$4.40†

* Surrounded with concrete. † Including pipe.

Character of Earth Excavation. — Beginning of section (in Bremen Street, about 300 feet south of Brooks Street) : 9 feet of clay and gravel filling, then 4 feet of peat, 3 feet of dry sand, wet sand to grade, so fine that 89 per cent. went through a sieve having 10,000 meshes to the square inch, and 25 per cent. went through one having 32,400 meshes to the square inch. This formation has extended for practically the entire length of the work done on Bremen Street to 150 feet south of Porter Street; corner of Decatur and Orleans streets : 5 feet of clay and gravel filling, 2 feet of clay, 5 feet of peat, clay to grade; corner of Decatur and Maverick streets : 8 feet of clay and gravel filling, 2½ feet of peat, fine sand, mixed with clay, below. These last two formations merged into each other about 200 feet south of the corner of Orleans and Decatur streets.

Masonry.

Contract price : —

Brickwork, American cement mortar, per cubic yard,	$13 50
Brickwork, Portland cement mortar, per cubic yard,	15 50
Concrete, American cement mortar, per cubic yard,	6 00
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size : —

6 inch,	94 feet.
8 inch,	326 "
10 inch,	624 "
Length of masonry completed,	1,025 "

Masonry was begun June 11, 1894; finished August 11.

Approximate cost of masonry per linear foot of trench, including underdrain, etc., to date (Sept. 30, 1894), $5.70.

Pipe.

Contract price (including excavation, pipe and laying, etc.) : —

1 foot 6 inches vitrified pipe, per linear foot,	$3 24
1 foot 3 inches and 1 foot vitrified pipe, per linear foot,	2 57

Diameters of underdrain laid and length of each size : —

6 inch,	475 feet.
8 inch,	243 "
10 inch,	129 "
Length of sewer pipe laid,	847 "

Pipe laying began Aug. 16, 1894, and is now (September 30) in progress.

One masonry man-hole has been built on the pipe sewer at a cost of about $114.

Approximate cost of section per linear foot of excavation, masonry and pipe, including labor, material, inspection and miscellaneous items to date (September 30) : —

Masonry sewer,	$12 60
Pipe sewer,	5 40

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Open cut.
Date of starting,	May 21, 1894,	Aug. 20, 1894.
Point of beginning,	Bremen Street, about 300 feet south of Brooks Street.	Just east of railroad tracks on Decatur Street.
Point reached,	In progress (September 30) 150 feet south of Porter Street.	In progress (September 30) corner of Orleans and Maverick streets.
Length,	1,254 feet,	817 feet.
Ordinary progress per week,	96 feet,	144 feet.
Appliances used,	Trench machine,	Trench machine.
Gang ordinarily employed in excavation.	32 men,	28 men.

The ground water has been kept in check by a 6 inch centrifugal pump at the corner of Marion and Bremen streets, and another at the corner of Decatur and Orleans streets. Excavation on Opening No. 1 ceased from August 29 to September 18. The contractors at first decided to give up work there, on account of various difficulties, but finally started again.

Foundation. — The bottom of the trench in Bremen Street has been in fine, wet sand, and the same has been the case for a length of about 300 feet, extending north from Maverick Street, in Orleans Street. In each instance the bottom has been excavated to a depth of about 1 foot below grade, and refilled with gravel. Elsewhere the bottom of the trench has been clay, and it has either been excavated to fit the invert of the sewer pipe, or enough fine material has been put around the pipe to secure an even bearing.

Miscellaneous. — In building the metropolitan sewer under the gate chamber of the city sewer at Porter Street a temporary connection for the sewage broke and caused a flooding of the trench. The connection was repaired in about three days, and then the sewage was pumped from the trench. The trench under this gate chamber was back-filled with concrete, in order that there should be no settlement. The city sewer in Bremen Street, from the beginning of the section to Porter Street, was cracked somewhat by the movement of the ground toward the trench. The surplus material from the trench has been used for filling adjacent low lands.

SECTION 39 (CONTRACT WORK), EAST BOSTON.

Location. — From the southerly side of Central Square, through Border and Condor streets to Meridian Street, with branch from Central Square through Border, Maverick and New streets to Sumner Street.

Diameters of sewers and length of each size: —

1 foot 3 inches (vitrified pipe),	2,000 feet.
1 foot (vitrified pipe),	3,189 "

Contractors. — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent. — George W. Judd.

Contractors' Principal Foreman. — John Colleran.

State Assistants.

Assistant Engineer: Seth Peterson.
Inspector: L. M. S. Horton.
Transitmen: Principals — George R. Winslow, Edward S. Foster.
" Assistants — George F. Chase, David H. Winslow.

Trench and Pipe.

Length of trench completed,	2,524.00 feet.
Length of pipe laid,	2,510.00 "
Average depth of trench excavation to bottom of underdrain,	14.50 "
Greatest depth of trench excavation to bottom of underdrain,	21.50 "
Average width, top of trench,	3.90 "
Average width, bottom of trench,	3.10 "

Cubic yards trench excavation per linear foot, 1.9.

Diameters of underdrain laid and length of each size: —

6 inch,	290 feet.
8 inch,	2,008 "

Approximate cost of trench and pipe per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc , to date (September 30), $3.90.

Pipe laying began June 19, 1894, and is now (September 30) in progress.

Character of Earth Excavation. — South-west side of Central Square: paving, 6 feet of clay and gravel filling, 8 feet of peat, 3 feet of sand, clay below; about 150 feet south of Lexington Street: paving, 2 feet of sand and gravel filling, coarse sand below. These two formations merge into each other about at the junction of Border Street and Central Square. At Eutaw Street: paving, 6 feet of gravel filling, below, sand and gravel, mingled with clay. This formation and the formation 150 feet south of Lexington Street merge about 200 feet north of Lexington Street. Five hundred feet north of Eutaw Street (where excavation is now — September 30 — going on): paving, 1 foot of gravel filling, — below, clay, gravel and boulders. This formation and the one at Eutaw Street merge about 400 feet north of Eutaw Street. Falcon Street to Meridian Street: paving, clay and gravel filling to bottom of trench.

Masonry (Man-holes).

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$12 79
Brickwork, Portland cement mortar, per cubic yard,	14 50
Concrete, American cement mortar, per cubic yard,	5 50
Concrete, Portland cement mortar, per cubic yard,	7 00

Number of man-holes built, 16.

Approximate cost per man-hole, $64.40.

Approximate cost of section per linear foot of trench and pipe (with man-holes), including labor, material, inspection and miscellaneous items, to date (September 30), $4.65.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Open cut.
Date of starting,	June 18, 1894,	June 29, 1894.
Point of beginning,	Falcon Street,	Central Square.
Point of ending,	Meridian Street,	In progress September 30 about 250 feet south of White Street.
Date of finishing,	July 5, 1894,	In progress September 30.
Length,	457 feet,	2,067 feet.
Ordinary progress per week,	150 feet,	175 feet.
Appliances used,	Thrown out by hand.	Trench machine.
Gang ordinarily employed,	25 men,	35 men.

The ground water was kept down by the use of a 6 inch centrifugal pump in Central Square.

Foundation. — For a length of 130 feet in Central Square the bottom of the trench was in fine, wet sand. This was excavated to a depth of 1½ feet below the bottom of the pipe, and the space refilled with gravel. The bottom of the trench elsewhere has been sand and gravel or clay and gravel. Where the bottom of the trench has been sand and gravel, the sewer pipe has been laid directly upon it; where the trench bottom has been clay and gravel, enough sand has been put around the pipe to fill the uneven spaces left in excavating and give an even bearing.

Miscellaneous. — Some of the surplus earth has been used for filling on low lots of land near by, and some has been hauled away.

Abandoned Work, Section 39.

Location.— From the intersection of Porter and Bremen streets, through Porter Street to Central Square.

The contractors first broke ground May 14, 1894. An effort was first made to tunnel, but fine running sand became so troublesome that this method was abandoned. May 19 an open cut was started, and a length of 63 feet excavated to grade with great difficulty, on account of the running sand, and 38 feet of pipe sewer was laid in an unsatisfactory manner.

As no further progress was made by the contractors the work was taken from them by the Board.

Construction by the Board began September 17. Splined and grooved sheeting, driven by hand, is used at the bottom of the trench to prevent the running of the sand.

SECTION 41 (CONTRACT WORK), MALDEN AND MELROSE.

At the date of my report for last year (Sept. 30, 1893) there remained less than 500 feet of this section to complete. All work on the section was finished by Nov. 20, 1893. The cost per linear foot was the same as for the work previously reported upon.

SECTION 43, SOMERVILLE AND CAMBRIDGE.

Location. — From a point about 600 feet southerly from the Mystic pumping station, Somerville, extending in a south-westerly direction, near Alewife Brook, crossing Broadway, Somerville; North Avenue, Middlesex Central Railroad, the Lexington & Arlington Branch Railroad, the Massachusetts Central Railroad and the Fitchburg Railroad, to Concord Avenue, Cambridge, with branches at Broadway, Somerville, at the Middlesex Central Railroad; and the Belmont branch from the extension of Spruce Street, Cambridge, extending nearly parallel with the Massachusetts Central Railroad to the Belmont town line.

Diameters of sewers and length of each size: —

Main line: —		
2 feet 11 inches by 3 feet 6 inches,		2,756 feet.
2 feet 5 inches by 3 feet 1 inch,	2,399 feet.	
2 feet 3 inches by 2 feet 11 inches,	1,666 "	
1 foot 11 inches by 2 feet 9 inches,	1,159 "	
		5,224 "
1 foot 6 inches (vitrified pipe),		2,795 "
Belmont branch and branches at Broadway and at Massachusetts Central Railroad: —		
1 foot 3 inches (vitrified pipe),		3,680 "

Contractors. — Metropolitan Construction Company of Boston, Mass.

Contractors' Superintendent (Year ending Sept. 30, 1894). — George W. Judd.

Contractors' Principal Foremen (Year ending Sept. 30, 1894). — John Colleran, P. Percello, Patrick Porter, James Long.

State Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Francis L. Sellew.

Inspectors: George A. Chase, James E. Coyne, Samuel P. McKenzie, Patrick McCarthy.

Transitmen: Principals — Edward S. Foster, George E. Howe.

" Assistants — George F. Chase, W. Gordon Crispin.

Trench and Tunnel.

	Largest Size Masonry Sewer, Main Line.	Smaller Sizes Masonry Sewer, Main Line.	1 Foot 6 Inches Pipe, Main Line.	1 Foot 3 Inches Pipe, Belmont Branch.
Length of trench completed (feet), . . .	2,711.00	5,123.00	2,795.00	3,581.00
Length of tunnel completed (feet), . . .	45.00	100.00	-	-
Average depth of trench excavation to bottom of underdrain (feet), ...	20.00	10.50	7.00	7.00
Greatest depth of trench excavation to bottom of underdrain (feet), ...	30.00	16.00	10.00	11.00
Average width, top of trench (feet), . . .	7.00	4.80	4.50	4.50
Average width, bottom of trench (feet), . .	5.50	4.80	4.50	4.50
Average depth from surface of ground to bottom of tunnel underdrain (feet), ...	26.00	16.00	-	-
Greatest depth from surface of ground to bottom of tunnel underdrain (feet), ...	26.00	17.00	-	-
Average width of tunnel excavation (feet), . .	5.60	4.50	-	-
Volume of trench excavation per linear foot (cubic yards), ...	4.40	1.90	1.20	1.20
Volume of tunnel excavation per linear foot (cubic yards), ...	1.30	0.90	-	-
Approximate cost of trench excavation per linear foot, including sheeting left in, excavation and refilling below masonry, back filling, etc., .	$4 50	$3 05	$2 70*	$1 85*†
Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., ...	4 25	2.90	-	-

* Including pipe.

† Branches of this size, 56 feet at Broadway and 43 feet at Massachusetts Central Railroad, come into this cost.

Character of Earth Excavation. — Main line: beginning about 600 feet southerly from the Mystic pumping station (the lower end of the section), 1 foot of loam on 3 feet of sand, hard-pan to bottom of excavation. This extends with slight variation for a length of about 1,450 feet in a southerly direction, where the formation changes to 3 feet of sand at the surface, 3 feet of clay, 3½ feet of sand, hard gravelly clay. About 400 feet north of Broadway the formation merged into 2 feet of loam, 3 feet of clayey gravel, 7 feet of hard-pan (rock took the place of the hard-pan for about 50 feet). About 200 feet southerly from Broadway: 2 feet of peat, with gravelly clay below. Fifteen hundred feet southerly from Broadway this merged into 2 feet of clay, 4 feet of sand, blue clay below. Five hundred feet southerly from North Avenue the formation changed to 3 feet of peat underlaid by fine, wet sand. This formation extended to the Fitchburg Railroad. From the Fitchburg Railroad to the end of the main line: 3 feet of peat (containing traces of clay), fine sand below. Belmont branch: beginning at foot of Spruce Street and extending 1,500 feet, 3 feet of peat and fine sand below. Thence to the Fitchburg Railroad, all peat; beyond, gravel and fine sand.

Masonry.

Contract price : —

Brickwork, 4 inches thick, American cement mortar, per cubic yard,	$13 95
More than 4 inches thick,	13 65
Brickwork, 4 inches thick, Portland cement mortar, per cubic yard,	15 75
More than 4 inches thick,	15 45
Concrete, American cement mortar, per cubic yard,	6 50
Concrete, Portland cement mortar, per cubic yard,	8 25

Diameters of underdrain laid and length of each size : —

6 inch,	2,744 feet.
8 inch,	5,416 "
10 inch,	1,688 "

Approximate cost of masonry per linear foot of excavation, including underdrain, etc. : —

Largest size (trench),	$5 55
Smaller sizes (trench),	4 50
Largest size (tunnel),	4 35
Smaller sizes (tunnel),	3 75

Length completed : —

Largest size sewer (trench),	2,711 feet.
Smaller sizes sewer (trench),	5,123 "
Largest size sewer (tunnel),	45 "
Smaller sizes sewer (tunnel),	100 "

Masonry begun in trench May 1, 1893; finished Dec. 20, 1893.
Masonry begun in tunnel Aug. 30, 1893; finished Dec. 20, 1893.

Pipe.

Contract price (including excavation, pipe and laying, etc.) : —

Main line, 1 foot 6 inches vitrified pipe, per linear foot,	$1 95
Belmont branch, 1 foot 3 inches vitrified pipe, per linear foot,	1 39

Diameters of underdrain laid and length of each size : —

6 inch,	1,356 feet.
8 inch,	3,624 "

Length of sewer pipe laid : —

Main line, 1 foot 6 inches, 2,795 feet; Belmont branch and shorter branches, 1 foot 3 inches, 3,680 feet, — 6,475 feet.

Pipe laying begun Nov. 24, 1892; finished on Belmont branch Aug. 7, 1893.

Approximate cost of section per linear foot of excavation, masonry and pipe, including labor, material, inspection and miscellaneous items : —

Main line : —	
Largest size masonry sewer,	$9 40
Smaller sizes masonry sewer,	7 40
1 foot 6 inches pipe sewer,	4 50
Belmont branch, 1 foot 3 inches pipe sewer,	4 00

NOTE. — The information regarding Section 43 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation.

	Old Opening.	Old Opening.	New Opening.	New Opening.
Character of opening,	Open cut,	Open cut,	Open cut,	Tunnel.
Number of tunnel headings,	-	- -	- -	One.
Date of starting,	May 1, 1893,	June 24, 1893,	Oct. 1, 1893,	Nov. 20, 1893.
Point of beginning,	-	- -	Broadway at end of tunnel,	Southerly side of Broadway.
Point of continuing from last year's work.	About 1,250 feet north of Broadway.	About midway between Middlesex Central and Massachusetts Central railroads.	- -	- -
Point of ending,	Broadway,	179 feet north of Spruce Street,	500 feet north of North Avenue,	Northerly side of Broadway.
Date of finishing,	Dec. 1, 1893,	October 25, 1893,	Nov. 22, 1893,	Dec. 20, 1893.
Length,	1,237 feet,	406 feet,	1,814 feet,	45 feet.
Ordinary progress per week,	144 feet,	100 feet,	225 feet,	11 feet.
Appliances used,	Trench machine,	Earth thrown out by hand,	Trench machine,	Incline.
Gang ordinarily employed,	35 men,	30 men,	35 men,	8 men.

It was stated in the report of last year that an open cut had extended northwesterly from Spruce Street for about 600 feet. The first 179 feet of this opening had its masonry placed in it, but the remaining portion of the trench was allowed to become partially refilled with earth, from natural causes. This refilled trench had to be dug out again, and, as the redigging was a part of the second old open cut mentioned above, the end of that piece of work is given at the point where the redigging ceased.

Pumps were used as follows: a 4 inch pulsometer at a point about 1,500 feet north of Broadway; an 8 inch centrifugal pump midway between Broadway and North Avenue, the same pump afterwards at the southerly side of Broadway; and a 6 inch centrifugal near the Middlesex Central Railroad.

Foundation. — From about 1,100 feet south of Broadway to within 100 feet of North Avenue the bottom of the trench varied from fine sand to blue clay. In the sand the foundation was made of concrete upon 10 inches of screened gravel, and in the clay the bottom of the trench was excavated to fit the invert of the sewer. Excavating the bottom of the trench to fit the invert of the sewer was done at other places, as follows: from about 740 feet north of Broadway and extending 100 feet in a southerly direction; from about 560 feet north of Broadway to about 780 feet south of Broadway, in hard-pan and gravelly clay. For about 500 feet southerly from a point 1,300 feet north of Broadway, fine running sand in the bottom of the trench was excavated to a depth of half a foot below the bottom of the masonry, and replaced by screened gravel. From the Middlesex Central Railroad to the foot of Spruce Street, a distance of about 1,100 feet, the bottom of the trench was fine running sand containing some silt. This was excavated to a depth of 1½ feet below the bottom of the masonry. Between the Middlesex Central and Massachusetts Central railroads, a distance of about 1,000 feet, screened gravel was used for refilling the trench bottom, and crushed stone was used for the remainder of the distance.

Difficulties. — The sewer was built under the Lexington & Arlington Branch Railroad, and the arch was here re-enforced with 6 inches of concrete. During the time of crossing under the railroad the tracks were held in position by 14 × 14 inch hard pine timbers.

Miscellaneous. — A 15 inch branch for the town of Arlington was laid under the Alewife Brook at Broadway, and another under the same brook at the Middlesex Central Railroad. In each case the branch was entirely surrounded with Portland concrete. All surplus earth gained by the sewer operations was left within the lines of the land taking.

SECTION 43½ (DAY WORK), MYSTIC RIVER SIPHON, ALEWIFE BROOK LINE.

Location. — Under and on either side of the Mystic River, Medford and Somerville, about 50 feet easterly from the Boston Avenue bridge. The river at this locality is about 80 feet wide and 10 feet deep at mean high water.

Length of work, about	150 feet.

Character of Proposed Structures. — A sand-catcher, southerly side of river, to be built of brick and concrete masonry; inside diameters, 6 feet by 7 feet; length, 28 feet. Siphon under river, to consist of about 86 feet of 24 inch vitrified pipe, surrounded by about 16 inches of Portland concrete. The elevation will be about 16 feet below that of the sewer on either side of the river. On each side of the river a man-hole or vertical sewer, of brick and concrete masonry, will connect the siphon with a chamber leading to the sewer already built.

State Assistants.

Assistant Engineer: Guy C. Emerson.
Transitman: Harry L. Ward.
Foreman: Paul Hill.
Sub-foreman: Patrick Gaffney.
Pile driving: Horace Sias.

Construction. — Work was commenced Sept. 17, 1894, and spruce piles were driven at intervals of 10 feet across the river, forming a bridge and guide for driving the sheet piling coffer-dam.

A coffer-dam 14 feet wide, made of 6 inch sheet piling, with the top about 3 feet above mean high water, was commenced from the northerly side of the river.

The ordinary working force is about 20 men.

SECTION 44, WINCHESTER.

Location. — From a point on the easterly side of the Boston & Lowell Railroad, about 150 feet southerly from Mystic Station, running northerly, crossing Bacon Street and through private and railroad land, crossing the Boston & Lowell Railroad about 300 feet southerly from Winchester Station; thence on the westerly side of the railroad through Common and Main streets, crossing Wedge Pond culvert, to Lake Street; thence through private lands, and crossing Blind Bridge Street and the Woburn Branch Railroad; thence along the north-easterly side of the railroad to a point about 500 feet south of Beggs & Cobb's tannery.

Diameters of sewers and length of each size: —

2 feet 7 inches by 2 feet 11 inches, ...	3,077 feet.
2 feet 3 inches by 2 feet 6 inches, ...	1,623 "
2 feet by 2 feet 5 inches, ...	908 "

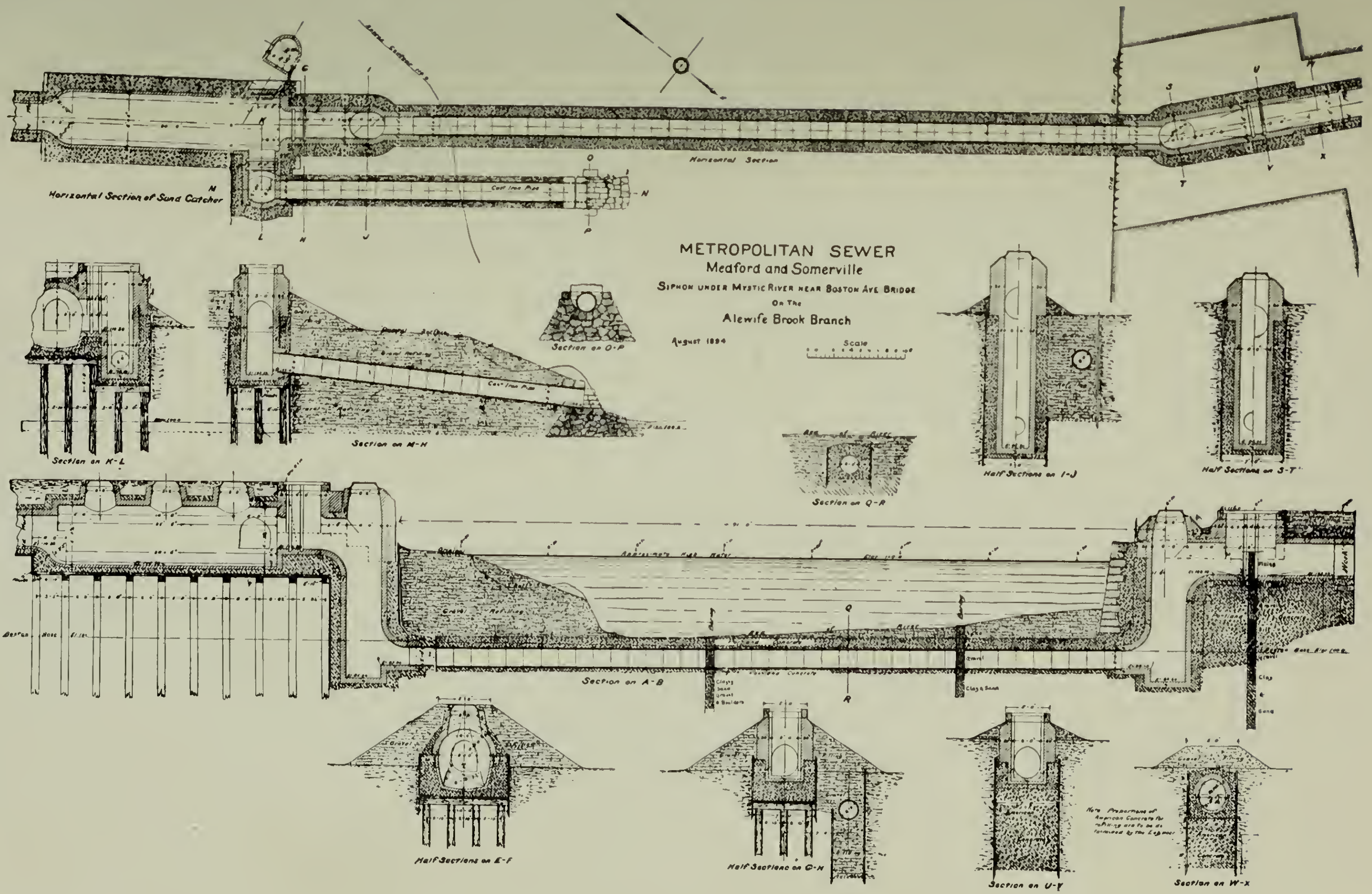
Contractors. — Jones & Meehan of Jamaica Plain, Mass.

Contractors' Superintendent (*Year ending Sept. 30, 1894*). — Michael Meehan of the above-mentioned firm.

Contractors' Principal Foreman (*Year ending Sept. 30, 1894*). — James Monahan.

State Assistants (*Year ending Sept. 30, 1894*).

Assistant Engineer: Edmund S. Davis.
Inspectors: Lucius M. S. Horton, Edward A. Clark.
Transitmen: Principal — Paul W. Rowell.
" Assistants — Fred Brett, Edward F. Adams.



Trench and Tunnel.

Length completed of trench excavation,	5,354.00 feet.
Length completed of tunnel excavation,	254.00 "
Average depth of trench excavation to bottom of underdrain,	13.60 "
Greatest depth of trench excavation to bottom of underdrain,	17.00 "
Average width, top of trench,	4.80 "
Average width, bottom of trench,	4.80 "
Average depth from surface of ground to bottom of tunnel underdrain: —	
Under Bacon Street,	28.00 feet.
In freight yard,	13.00 "
Under Woburn Branch Railroad,	22.00 "
Greatest depth from surface of ground to bottom of tunnel underdrain,	28.00 "
Average width of tunnel excavation,	5.00 "
Volume trench excavation per linear foot,	2.2 cu. yds.
Volume tunnel excavation per linear foot,	1.0 "

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., $4.15.

Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., $3.40.

Character of Earth Excavation. — About 300 feet at the southerly end of the section, a stratum of sand above one of gravel; thence to the freight yard, mingled sand and gravel; in freight yard for about 120 feet, some rock excavation; from freight yard to Winchester station, sand and gravel; Winchester station to Wedge Pond culvert, filling near the surface and an average of 4 feet of gravel, underneath mostly sand to bottom of excavation; Wedge Pond culvert to where the sewer leaves Main Street, about 7 feet of gravel filling near surface, then 2 feet of peat, then fine sand in bottom; thence to within about 200 feet of the northerly end of the section, mingled sand and gravel; northerly 200 feet of trench, about 5 feet of peat near the surface, sand underneath.

Masonry.

Contract price: —	
Brickwork, American cement mortar, per cubic yard,	$14 00
Brickwork, Portland cement mortar, per cubic yard,	17 00
Concrete, American cement mortar, per cubic yard,	7 00
Concrete, Portland cement mortar, per cubic yard,	9 00
Diameters of underdrain laid and length of each size: —	
8 inch,	5,076 feet.
10 inch,	560 "
Approximate cost of masonry per linear foot of trench, including underdrain, etc.: —	
Trench,	$4 60
Tunnel,	6 65
Lengths of masonry completed: —	
Trench,	5,354 feet.
Tunnel,	254 "

Masonry was begun in trench, concrete, June 21, 1893; brick masonry, June 22, 1893; finished on the respective dates of Jan. 5 and 17, 1894.

Masonry begun in tunnel July 27, 1893; finished Dec. 6, 1893.

Approximate cost of section per linear foot of tunnel and trench excavation and masonry, including labor, material, inspection and miscellaneous items, $8.90.

NOTE. — The information regarding Section 44 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation.

	Old Opening.	New Opening.	New Opening.	New Opening.
Character of opening,	Open cut,	Open cut,	Tunnel under Woburn Branch Railroad.	Open cut.
Number of tunnel headings,	- -	- -	One,	- -
Date of starting,	Aug. 11, 1893,	Nov. 3, 1893,	Oct. 27, 1893,	Oct. 9, 1893.
Point of beginning,	- -	Southerly side of Woburn Branch Railroad, and worked back to Blind Bridge Street, and began again near the intersection of Main and Lake streets.	North side of Woburn Branch Railroad.	North side of Woburn Branch Railroad.
Point of continuing from last year's work.	Near the intersection of Common and Church streets.	- -	- -	- -
Point of ending,	Near the intersection of Main and Lake streets.	Blind Bridge Street,	South side of Woburn Branch Railroad.	About 500 feet south of Beggs & Cobb's tannery.
Date of finishing,	About Jan. 1, 1894,	Jan. 17, 1894,	Nov. 5, 1893,	Dec. 9, 1893.
Length,	1,593 feet, including Wedge Pond culvert.	236 feet,	56 feet,	575 feet.
Ordinary progress per week,	About 123 feet,	About 40 feet; not worked regularly,	About 40 feet,	About 80 feet.
Appliances used,	Trench machine, except at Wedge Pond culvert, where earth was thrown out by hand.	Earth thrown out by hand,	Earth thrown out by hand,	Earth thrown out by hand.
Gang ordinarily employed,	51 men,	20 men,	5 men,	25 men.

The pumping was done from pump-wells about 500 feet apart along the line, in each of which either a 4 inch or a 6 inch centrifugal pump was used.

Foundation. — In Main Street, at and near Wedge Pond culvert, for a length of 153 feet extending southerly from a point about 246 feet south of the culvert and for 209 feet including the culvert and extending northerly, the bottom of the trench was loose running sand, mingled with fibrous vegetable matter. The sewer in this place was built upon piles. The piles were from 10 to 25 feet long, 12 inches in diameter at the butts and driven in bents of two. Eight inch by 8 inch caps were used, on which a 3 inch plank platform was placed. Excavation has been made from 6 inches to 1 foot below the bottom of the masonry, and gravel refilling put in, as follows: 65 feet in the freight yard, 187 feet in Common Street, 553 feet in Main Street, and 510 feet on the northerly side of the Woburn Branch Railroad. The material in the bottom of the trench, except at the place last named, was fine sand, with fibrous material in places. On the northerly side of the railroad two pockets of peat were found in the trench bottom. Elsewhere the bottom of the trench was sand, with gravel in some places, and the invert of the sewer was either laid in concrete or in a cradle foundation.

Miscellaneous. — The sewer was built under the Wedge Pond culvert, and the cross-section was here changed to a 30 inch cast iron pipe. The pipe was surrounded by Portland concrete masonry, which rested on a platform and pile foundation. The sewer also crossed under the Woburn Branch Railroad. The trench outside of the sewer at this place was filled with Portland concrete masonry. During the construction of the sewer in Main Street the street cars between Winchester and Woburn were not able to run to the Winchester end of their track, and had to stop in Winchester at the head of the trench.

SECTION 44½ (CONTRACT WORK), WEST MEDFORD AND WINCHESTER.

Location. — From the northerly end of Section 22 in Medford, near the outlet of the Mystic valley sewer at the lower Mystic Lake, along the bed of the old Middlesex Canal and through private and railroad lands on the westerly side of the Boston & Lowell Railroad, crossing the Abbajona River and across said railroad to a point on easterly side of railroad about 150 feet southerly from the Mystic Station in Winchester. The pipe crossing at Abbajona River is not embraced in the contract work.

Diameters of sewers and length of each size: —

2 feet 11 inches by 3 feet 3 inches, ...	3,298 feet.
2 feet 9 inches by 3 feet 1 inch, ...	2,308 "

Contractors. — Weaving, Booth & Co. of Dorchester, Mass.

Contractors' Superintendent (Year ending Sept. 30, 1894). — A. E. Weaving, a member of the above-named firm.

Contractors' Principal Foreman (Year ending Sept. 30, 1894). — George Robinson.

State Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Edmund S. Davis.
Inspector: Michael Garra.
Transitmen: Principal — Guy C. Emerson.
" Assistants — Arthur H. Pratt, Joseph M. Mahoney, J. T. P. Jones.

Trench.

	Larger Sewer.	Smaller Sewer.
Length completed (feet), ...	3,298.00	2,308.00
Average depth of excavation to bottom of masonry (feet), . . .	15.00	7.17
Greatest depth of excavation to bottom of masonry (feet), . . .	21.50	15.00
Average width, top of trench (feet), ...	5.50	5.25
Average width, bottom of trench (feet), ...	4.25	5.25
Volume of excavation per linear foot (cubic yards), ...	2.70	1.40
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., . . .	$2 25	$2 55

Character of Earth Excavation. — Beginning of section to near Mystic sewage disposal works, fine compact sand and gravel; thence to end of section on easterly side of railroad, about 150 feet southerly from Mystic station in Winchester, coarse sand and gravel, with a few boulders and some peat just north of Abbajona River.

Masonry.

Contract price: —

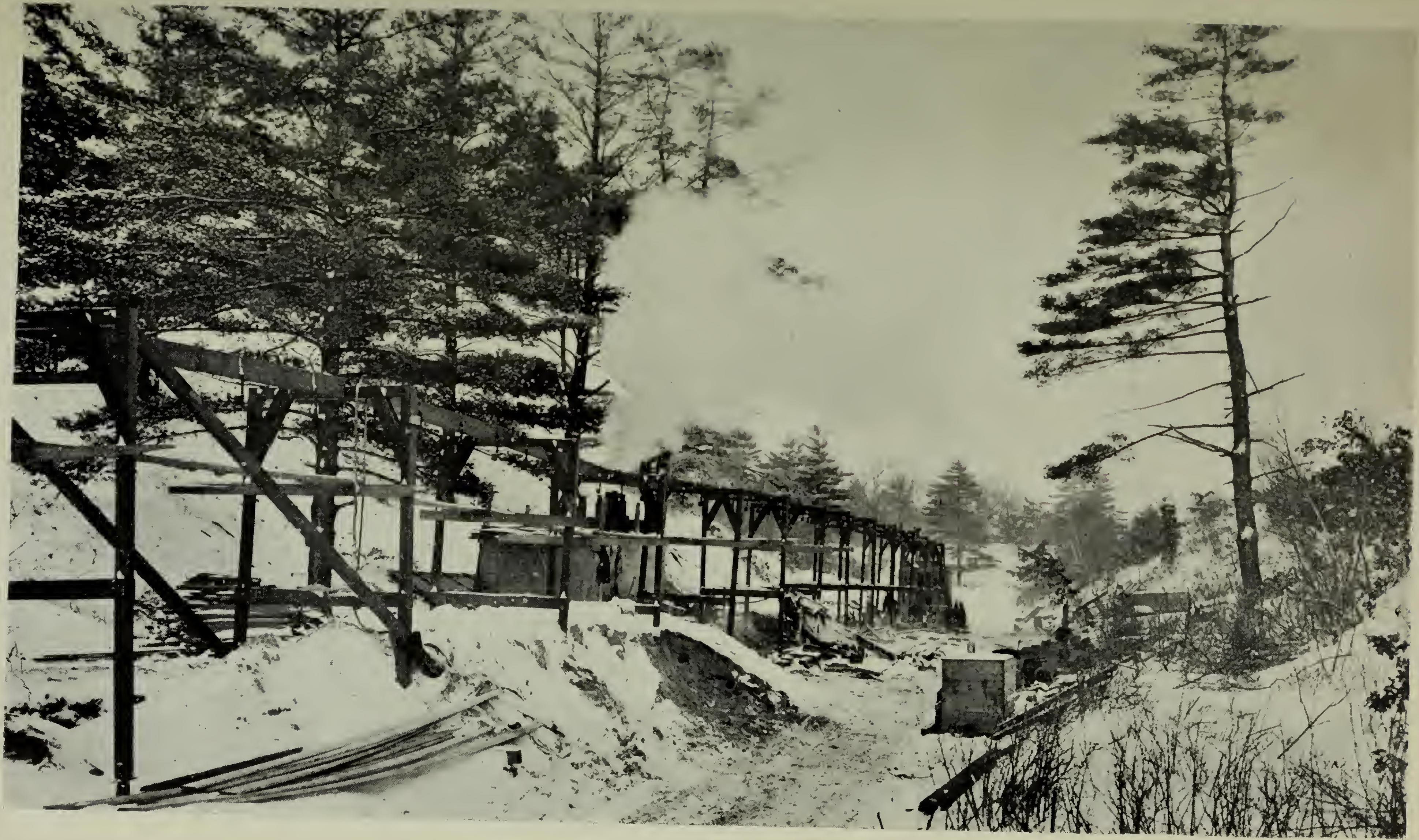
Brickwork, American cement mortar, per cubic yard, ...	$11 75
Brickwork, Portland cement mortar, per cubic yard, ...	13 20
Concrete, American cement mortar, per cubic yard, ...	3 40
Concrete, Portland cement mortar, per cubic yard, ...	4 85

Diameters of underdrain laid and length of each size: —

6 inch, ...	772 feet.
8 inch, ...	608 "

Approximate cost of masonry per linear foot of trench, including underdrain, etc , $3.90.

Length of masonry completed, ...	5,605 "



Section 44½, Medford. Bed of Old Middlesex Canal. Jan. 11, 1894.

Masonry begun Sept. 2, 1893; finished Jan. 12, 1894.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, $6.60.

NOTE. — The information regarding Section 44½ following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation.

	Old Opening No. 1.	Old Opening No. 2.	New Opening.
Character of opening, .	Open cut, . .	Open cut, . .	Open cut.
Date of starting, . .	Aug. 28, 1893, . .	Sept. 19, 1893, . .	Oct. 7, 1893.
Point of continuing from last year's work.	170 feet south of Abbajona River.	275 feet south from Mystic Station.	-
Point of beginning, .	-	-	Near Mystic sewage disposal works.
Point of ending, . .	At Abbajona River,	Easterly side of railroad, about 150 feet south from Mystic Station, Winchester.	Northerly end of Section 22 in Medford, near the outlet of the Mystic valley sewer at the lower Mystic Lake.
Date of finishing, .	Oct. 4, 1893, . .	Oct. 7, 1893, . .	Jan. 12, 1894.
Length, ...	170 feet, . . .	123 feet, . . .	3,444 feet.
Ordinary progress per week.	At rate of 345 feet,	123 feet, . . .	249 feet.
Appliances used, . .	Thrown out by hand,	Thrown out by hand,	Trench machine.
Gang ordinarily employed in excavation.	58 men in all worked	on these two openings.	58 men.

The ground water was kept down by a 6 inch centrifugal pump near the beginning of the section (northerly end of Section 22, in Medford, near the outlet of the Mystic valley sewer at the lower Mystic Lake), and a 4 inch centrifugal pump near the Mystic sewage disposal works.

Foundation. — From the beginning of the section to near the Mystic sewage disposal works, a distance of about 3,445 feet, the bottom of the trench was fine, compact sand and gravel, which was excavated to fit the invert of the sewer.

Miscellaneous. — To prevent the percolation of water through the walls, the entire length of the sewer built this year was coated with pitch between the inner and outer rings. From near the Mystic sewage disposal works to the Abbajona River, a length of about 715 feet, excluding a street intervening, an embankment of surplus earth was built over the sewer to a height of about 2½ feet above the natural surface. Other surplus earth has been left within the lines of the taking.

SECTION 44½ (ABANDONED CONTRACT WORK), SIPHON, ABBAJONA RIVER, WINCHESTER.

Location. — Under and on either side of Abbajona River, westerly side of Boston & Lowell Railroad, about 400 feet southerly from Mystic station.

Length of work, about	80 feet.

Character of structures: —

Southerly side of river —

Brick masonry man-hole, 3 feet by 4 feet diameter, with sump in bottom. This is connected with the main sewer by a "goose-neck" of brick masonry. Where this man-hole construction projects into the river it is protected by a pier of granite masonry backed with concrete.

Siphon under river —

20 inch Akron pipe surrounded by concrete and rubble masonry. The top of this siphon is protected from erosion by 6 inch flag-stones embedded in the concrete.

Northerly side of river —

Brick masonry sand-catcher, with an inside diameter of about 6 feet by 6 feet by 14 feet. This is protected in the same manner as the man-hole on the southerly side of the river.

The total water way between the piers is 32.5 feet at the top and 26 feet at the bottom.

Contractors (started work and abandoned it later). — Thomas J. Young & Co. of Boston, Mass. Mr. Thomas J. Young, of the above-named firm, acted as superintendent.

Contractors' Foreman. — James McManus.

State Assistants.

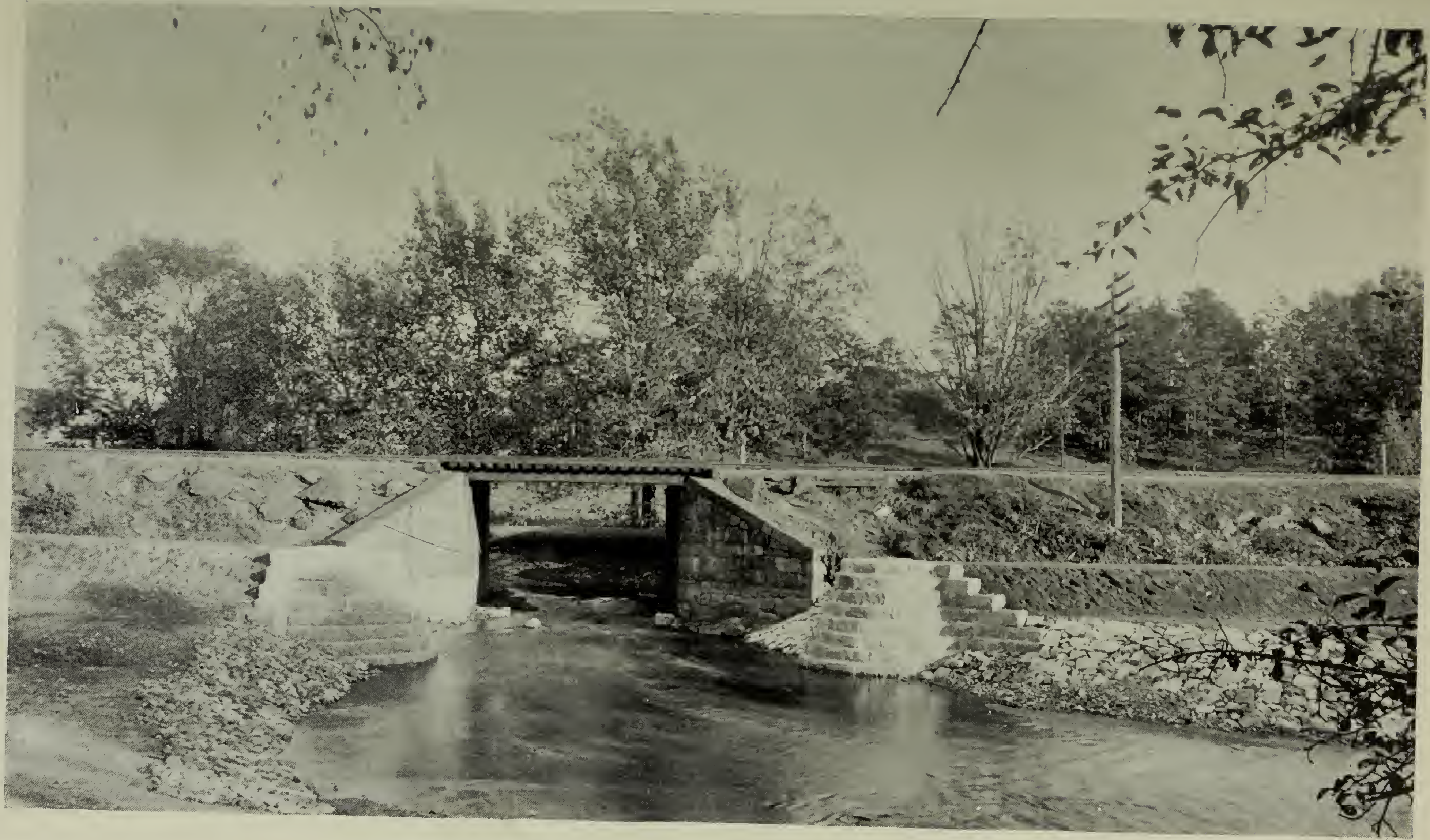
Assistant Engineer: Edmund S. Davis.
Transitmen: Principal — Guy C. Emerson.
" Assistants — Harry L. Ward, J. T. P. Jones.
Foreman: Paul Hill.
Sub-foreman: Patrick Gaffney.

Volume of Excavation.

Man-hole, goose-neck and pertaining structures, . . .	80.00 cubic yards.
Siphon under river, ...	36.40 " "
Sand-catcher and pertaining structures, ...	70.00 " "

Volume of Masonry.

Brick masonry: —	
Man-hole and goose-neck, ...	13.1 cubic yards.
Sand-catcher, ...	10.5 " "
Split granite masonry: —	
Piers, ...	26.0 " "
Concrete and rubble masonry: —	
About man-hole and goose-neck, ...	30.0 " "
About 20 inch pipe siphon, ...	33.0 " "
About sand-catcher, ...	35.0 " "



Section 44$\frac{1}{2}$, Winchester. Siphon at the Abbajona River. Sept. 30, 1894.

Construction by Contractors. — A contract for doing the work was signed Dec. 2, 1893, and work was begun soon after on the northerly side of the river. The material to be excavated was sand and gravel, with large boulders of split granite. These boulders were the remains of a former bridge of the Boston & Lowell Railroad over the Abbajona River. The boulders made it difficult to drive the sheeting (4 inch) for a coffer-dam, and wash-outs under the bottom of the one constructed were frequent. Two centrifugal pumps, 4 inch and 6 inch, were at times unable to keep down the flow of water into the coffer-dam. The contractors completed the sand-catcher and stone pier on the north side of the pier, and about 6 feet of siphon outside of the pier. Work was abandoned by the contractors March 6, 1894. The water in the river at that time was about 9½ feet deep over the top of the siphon masonry.

Construction directly by the Board. — The partial damming of the river by the contractors' coffer-dam caused a very rapid current between the abutments of the Boston & Lowell Railroad bridge about 23 feet east of the siphon. To avoid any possible danger of undermining these abutments, the water-way was enlarged by removing a portion of the contractors' coffer-dam.

By July 21, 1894, the water in the river over the line of the siphon was only about 1 foot in depth, and on that date construction directly by the Board began. A coffer-dam was built similar to the one built by the contractors, and excavation and masonry were carried on until completion during the present month (September, 1894). A 6 inch Blake pump took care of the water in the coffer-dam.

SECTION 45, WINCHESTER.

At the time of reporting on this section last year there remained about 344 feet of masonry to be laid at the upper end of the section, near Washington Street, and some embankment work to complete. The masonry was finished Oct. 5, 1893. The last of the embankment work was finished about Oct. 18, 1893. The cost of the whole section was 4.80 per linear foot.

SECTION 46, WINCHESTER, WOBURN AND STONEHAM.

Location. — From Washington Street near the entrance to Calvary Cemetery, in Winchester, through private lands on the westerly side of Willow Brook, crossing Willow Brook and thence through private lands on the easterly side of Clear Water Brook, crossing Hill Street, Stoneham Branch Railroad and Maple Street in Woburn to Montvale Avenue in Stoneham, near the Woburn and Stoneham town line.

Diameters of sewers and length of each size: —

1 foot 10 inches by 2 feet 3 inches,	2,375 feet.
1 foot 6 inches by 2 feet,	1,081 "
1 foot 3 inches (Akron pipe),	2,301 "

Contractor. — Charles Linehan of Cambridge, Mass.; Mr. Linehan acting as his own superintendent.

Contractor's Principal Foreman. — Giuseppe Chino.

State Assistants (Year ending Sept. 30, 1894).

Assistant Engineer: Edmund S. Davis.
Transitmen: Principal — Guy C. Emerson.
" Assistant — J. T. P. Jones.
Inspector: Paul Hill.

Trench and Tunnel.

	Brick Sewers.	Pipe Sewer.
Length of trench completed (feet),	3,456.00	2,216.00
Length of tunnel completed (feet),	-	85.00
Average depth of trench excavation to bottom of underdrain (feet),	10.00	8.70
Greatest depth of trench excavation to bottom of underdrain (feet),	18.00	17.50
Average width, top of trench (feet),	3.68	3.50
Average width, bottom of trench (feet),	3.68	3.00
Average depth from surface of ground to bottom of tunnel underdrain (feet),	-	21.00
Greatest depth from surface of ground to bottom of tunnel underdrain (feet),	-	27.00
Average width of tunnel excavation (feet),	-	4.50
Cubic yards trench excavation per linear foot,	1.32	0.95
Cubic yards tunnel excavation per linear foot,	-	1.00
Approximate cost of trench or tunnel per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc.,	$1 40	-

Character of Earth Excavation. — Near Washington Street to near the glue factory in Oakland, about 1 foot of loam, sand and gravel to bottom of excavation, with the exception that this formation was varied at two places on the westerly side of Willow Brook where fine sand was found in the bottom of the trench; from near the glue factory to Hill Street, loam, with material resembling hard-pan below; each side of Hill Street, a small quantity of a kind of trap rock found in the bottom of the trench; Hill Street to the upper end of the section, 8 inches to a foot of loam, then coarse sand and gravel to the bottom of the trench.

Masonry and Pipe.

Contract price, masonry: —	
Brickwork, American cement mortar, per cubic yard,	$13 00
Brickwork, Portland cement mortar, per cubic yard,	16 00
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	6 00
Contract price, pipe sewer: —	
1 foot 3 inch pipe sewer (including trench),	1 36
Diameters of underdrain laid and length of each size: —	
6 inch,	2,158 feet.
8 inch,	3,515 "
Approximate cost of masonry or pipe per linear foot of excavation, including underdrain, etc.: —	
Brick sewers (trench),	$3 10
Pipe sewer (including trench and brick man-holes), trench,	1 85
Pipe sewer (including excavation, concrete around pipe, etc.), tunnel,	2 40
Length completed: —	
Brick sewers (trench),	3,456 feet.
Pipe sewer (trench),	2,216 "
Pipe sewer (tunnel),	85 "

Masonry begun April 26, 1893; finished Nov. 11, 1893.
Pipe laying begun Sept. 19, 1893; finished Nov. 9, 1893.

Approximate cost of brick sewers per linear foot, including excavation and masonry, labor, material, inspection and miscellaneous items, $3.10.

Approximate cost of the 1 foot 3 inch pipe sewer per linear foot of excavation and pipe, including masonry at man-holes, labor, material, inspection and miscellaneous items, $1.02.

NOTE. — The information regarding Section 46 following this note relates solely to the year ending Sept. 30, 1894. For a description of the work performed prior to this year, see the fifth annual report.

Excavation. — The excavation this year has been wholly for the pipe sewer, and has comprised 85 feet of tunnel by two headings under the Stoneham Branch Railroad, and 1,509 feet of open cut from thence to the upper end of the section at Montvale Avenue in Stoneham, near the Woburn and Stoneham town line. Excavation was finished about Nov. 20, 1893. In tunnelling under the railroad the ordinary progress per week was about 30 feet, and on the open cut it was about 300 feet. The excavated material in the tunnel was wheeled out; from the open cut it was thrown out by hand. Three men ordinarily worked in each tunnel heading, and 32 men ordinarily worked on the open cut.

There was a pump-well near Hill Street and another one near Maple Street. The pumping was done by two 4 inch centrifugal pumps, which were used alternately first at one pump-well and then at the other.

Foundation. — The bottom of the trench consisted of sand and coarse gravel. The underdrain was laid in the centre of the trench, and the 15 inch Akron pipe sewer was laid about four inches above.

Miscellaneous. — The 15 inch pipe sewer under the Stoneham Branch Railroad was surrounded with about 6 inches of Portland concrete.

Section 47, Winchester and Woburn.

Location. — From the corner of Main and Lake streets, Winchester, through Lake and Linden streets, then in a general north-westerly direction through private lands to a point near the Boston Ice Company's houses on Lake Avenue, Woburn, about 20 feet beyond the boundary line between Winchester and Woburn.

Diameters of sewers and length of each size (vitrified pipe): —

20 inch,	1,088 feet.
18 inch,	1,485 "
15 inch,	1,937 "

Contractors. — Lindsey & Cudmore of Somerville, Mass.

Contractors' Superintendent. — William Lindsey of the above-mentioned firm.

Contractors' Principal Foreman. — James Crooks.

State Assistants.

Assistant Engineer and Inspector: Guy C. Emerson.
Transitman: Principal — Harry L. Ward.

Trench and Pipe.

	20 Inch Sewer.	18 Inch Sewer.	15 Inch Sewer.
Length of trench completed (feet),	1,088.00	1,485.00	1,937.00
Length of pipe laid (feet),	1,088.00	1,252.00	1,937.00
Average depth of trench excavation to bottom of underdrain (feet),	5.40	11.80	6.50
Greatest depth of trench excavation to bottom of underdrain (feet),	9.40	17.50	10.00
Average width, top of trench (feet),	3.67	3.67	3.33
Average width, bottom of trench (feet),	3.67	3.67	3.33
Cubic yards excavation per linear foot of trench,	.74	1.60	.80
Diameters of underdrain laid and length of each size: —			
4 inch, 425 feet.	-	-	-
6 inch, 2,386 "	-	-	-
8 inch, 895 "	-	-	-
Approximate cost of trench and pipe per linear foot,	$1 25	$1 60*	$1 28†

* Including sheeting left in, excavation below grade. † Including sheeting left in.

Pipe work was begun May 18, 1894, and is now (September 30) in progress.

Character of Earth Excavation. — Sand and gravel for entire length; very fine sand from about the end of Linden Street to near Cowdry & Nichols' factory, also fine sand containing considerable water from the crossing of Cowdry & Nichols' canal to near Russell's Brook; a small pocket of clay underlaid with coarse gravel near the upper end of the section.

Masonry (Concrete and Man-holes).

Contract price: —

Brickwork, American cement mortar, per cubic yard,	$12.00
Brickwork, Portland cement mortar, per cubic yard,	14.00
Concrete, American cement mortar, per cubic yard,	5.00
Concrete, Portland cement mortar, per cubic yard,	7.00

Number of man-holes built, 27.

Approximate cost per man-hole, $44.08.

Approximate cost of section per linear foot of trench and pipe (with man-holes), including labor, material, inspection and miscellaneous items, to date (September 30), $2.20.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Open cut.
Date of starting,	May 17, 1894,	Sept. 7, 1894.
Point of beginning,	Corner of Main and Lake streets.	West side of Russell's Brook.
Point of ending,	West side of Russell's Brook.	Upper end of section near the Boston Ice Company's houses on Lake Avenue, Woburn.
Date of finishing,	Sept. 30, 1894,	Sept. 27, 1894.
Length,	3,805 feet,	705 feet.
Ordinary progress per week,	400 feet,	210 feet.
Appliances used,	Thrown out by hand,	Thrown out by hand.
Gang ordinarily employed,	25 men,	25 men.

From the beginning of the section to the canal carrying water to Cowdry & Nichols' factory, the pumping was done by two hand pumps. Quicksand containing much ground water was encountered between this canal and Russell's Brook. A pump-well was dug near Cowdry & Nichols' canal, and this well was pumped from by a 6 inch Blake pump. Two inch pipe wells 10 feet apart were driven to the stratum of gravel beneath the quicksand, and the level of the ground water was lowered by pumping from them with a 4 inch Blake pump. The level of the ground water here was still further lowered by pumping with a 6 inch centrifugal pump from a deep well dug near Russell's Brook.

Foundation. — The quicksand just referred to extended for a length of 650 feet. It was excavated to a depth of about 1 foot below the bottom of the sewer pipe, and replaced by coarse gravel. Elsewhere the bottom of the trench was sand and gravel, which was excavated as nearly as practicable to the shape of the invert of the sewer pipe.

Miscellaneous. — An inverted siphon was built under Horn Pond Brook in Lake Street. The water in the brook was very low, so that no special difficulty was experienced. An earth dam was made half-way across the brook, and half of the length of the siphon was built under its protection. The dam was then removed, and the process repeated for the other half of the siphon. By working in this manner half of the channel of the brook remained open at all times. One hand pump took care of the water inside of the dam. This siphon passes under a bridge with abutments made of very inferior dry rubble masonry. The part disturbed was relaid in cement mortar. The sewer pipe is near the surface in Lake Street and in a portion of Linden Street, and is also near the surface where it crosses under Horn Pond Brook and under Russell's Brook. In each of these places it has been surrounded with concrete. An embankment 1 foot above the natural surface has been built over the sewer near Cowdry & Nichols' factory. Some of the surplus earth was used making this. Other portions of the surplus have been used for filling the old bed of Horn Pond Brook, where its course has been changed, and in making mounds about man-holes. The remainder of the surplus has been left within the lines of the taking. Excavation is now (September 30) entirely completed. It is probable that the pipe laying and back-filling will be completed in about two weeks.

Cement Testing.

Approximately 30,000 barrels of Portland cement and 20,000 barrels of American cement have been used during the year; 12,500 tests of cement have been made, and about 2,500 barrels rejected.

The test for fineness has been through sieves of 2,500, 10,000, 14,400, 22,500 and 32,400 meshes to the square inch.

The tests for setting qualities have been by cold and hot water, both salt and fresh; and by steam at various temperatures.

Reliance has been placed mainly upon long-time tests, and the recorded experience of cements which have been used for years.

Table of Progress.

The following table recapitulates to some extent the detailed information given in the foregoing pages and in reports of preceding years. The Charles River valley sections are designated by letters and those of the North Metropolitan district by numbers: —

TABLE OF SEWER WORK COMPLETED AND IN PROGRESS SEPT. 30, 1894.

Section.	LOCALITY.	NAME OF CONTRACTOR.	Total Length of Section. Feet.	SIZE OF SEWER.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1894. Feet.	Date of Completion named in Contract.
O	Boston,	Built by city of Boston,	1,897	6' 6",	23	1,897	May, 1890
A	Boston,	H. C. Eyre,	3,701	5' 6",	20.3	3,701	Aug. 31, 1891
B	Boston and Brookline,	H. C. Eyre,	2,962	5' 6',	18.5	2,962	Feb. 28, 1891
C	Brighton,	National Construction Co.,	5,787	4' 10",	16.4	5,787	Aug. 31, 1891
D	Brighton,	National Construction Co.,	5,300	4' 10'×5' 3",	17.2	5,300	July 31, 1891
E	Brighton,	Jones & Meehan,	8,027	4' 6"×5' 1",	14.7	8,027	Nov. 30, 1891
F	Newton and Watertown,	Jones & Meehan,	7,675	4' 2"×4' 9", 3' 11"×4' 5",	10.4	7,673	Nov. 30, 1891
G	Newton,	Jones & Meehan,	2,800	3' 11"×4' 5", 3' 6"×4',	19.1	2,800	Nov. 30, 1891
H	Newton,	Metropolitan Construction Co.,	4,497	3' 6"×4',	13.7	4,497	Nov. 30, 1891
1	Deer Island,	Day work,	1,925	6' 3",	14	1,506	-
2	Deer Island,	National Construction Co.,	2,120	Outfall sewer, 6'×6' to 6'×10', Main sewer, 9',	17 28	2,120	Feb. 29, 1892
3	Deer Island,	R. A. Malone & Co.,	2,641	9',	26	2,641	April 30, 1891
3½	Deer Island and Winthrop,	Day work,	430	Main sewers, 9', 6' 4", Sand-catcher, 16'×16', Siphon, 6' 2",	21 23 13	138 28 264	-
4	Winthrop,	Metropolitan Construction Co.,	5,710	9',	22	5,710	June 30, 1891

TABLE OF SEWER WORK COMPLETED, ETC. — *Continued.*

Section.	Locality.	Name of Contractor.	Total Length of Section. Feet.	Size of Sewer.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1894. Feet.	Date of Completion named in Contract.
5	Winthrop,	Metropolitan Construction Co.,	4,600	9',	16	4,600	July 31, 1891
6	Winthrop,	Metropolitan Construction Co.,	4,113	9',	18	4,113	May 31, 1891
7	Winthrop and East Boston,	Trumbull & Ryan,	848	Main sewer, 8' 6"×9' 2", Sand-catcher, 16'×16' 5", and siphon approaches, Siphon (3 parallel lines), 5',	6.5 11.4 13.6	777	June 1, 1893
8	Breed's Island,	Charles Linehan,	4,126	9',	16.4	4,126	Aug. 31, 1891
9	East Boston and Chelsea,	Charles Linehan,	3,383	9',	15.8	3,383	May 31, 1891
10	East Boston and Chelsea,	Day work,	709	Siphon, 5' 8", Sand-catcher, 15' 5"×16' 1",	53* 23†	709	-
11	Chelsea,	Charles Linehan,	3,030	2' 1"×2' 10",	17.0	2,003	Sept. 30, 1894
12	Chelsea,	Orin P. Roberts,	3,034	8' 4"×9',	27.0	3,034	April 30, 1893
14	Chelsea,	Metropolitan Construction Co.,	3,445	8' 10", 8' 4"×9', 8' 2"×8' 10",	28.60* 37.0†	3,445	Dec. 30, 1893
15	Chelsea,	Christy McBride,	1,754	8' 2"×8' 10",	23.2	1,754	May 31, 1892
16	Everett,	R. A. Malone & Son,	4,431	8' 2"×8' 10", 5' 10"×6' 4",	21.1 20.7	4,431	Nov. 30, 1892
17	Everett,	Christy McBride,	3,528	5' 10"×6' 4", 4' 8"×5' 1",	21.4	3,528	Sept. 30, 1892
17½	Everett,	Metropolitan Construction Co.,	1,627	4' 8"×5' 1",	17.0	1,627	Sept. 30, 1892

19	Everett and Medford,	Day work,	496	Sand catcher, 10 × 11' 3", 4' 8"×5' 1", 3' 6", 3' 6", 4' 8"×6' 2", 3' 6",	13.0 12.7	40 35 229	–
20	Medford,	John Sheehan,	9,170	Main line, 4' 8"×5' 1", 4' 5"×4' 8", Edgeworth branch, 2',	18.5 13.3	9,170	April 30, 1893
21	Medford,	National Construction Co.,	8,030	4' 5"×4' 8", 4' 3"×4' 6",	14.0	8,030	Feb. 28, 1893
21	Medford (Gravelly Brook culvert),	Sub-contractors: Wm. H. Lenox & Co., A. W. Bryne,	54	4' 5"×4' 8",	12.8	54	–
21	Medford (Winthrop Street culvert),	Day work,	181	4' 3"×4' 6",	6.5	181	–
22	West Medford,	Andrew W. Bryne,	6,033	3' 4"×3' 6",	23.0* 28.0†	5,347 686	June 30, 1893
23	Everett,	R. A. Malone & Sons,	2,268	6'×6' 8",	25.3	2,268	June 30, 1892
24	Everett and Charlestown,	Metropolitan Construction Co.,	2,332	6'×6' 8",	25.0	2,332	Sept. 30, 1892
25	Charlestown,	Day work,	1,540	Main sewer, 6'×6' 8", 6'×7' 1", Siphon, 5',	23.1* 44.0†	1,540	–
25½	Charlestown,	Day work,	585	6' 7"×7' 5", 6' 5"×7' 2",	27.3	585	–
26	Charlestown and Somerville,	Harry P. Nawn,	3,750	6' 5"×7' 2", 5' 9"×6' 6",	34.3† 23.5* 28.8†	3,750	Nov. 30, 1893
26‡ 27‡	Somerville,	Day work,	950	5' 9"×6' 6",	35.0†	950	–
27	Somerville and Cambridge,	McGovern & Kitch, Metropolitan Construction Co., Day work,	4,326	5' 9"×6' 6", 5' 2"×5' 9",	24.4* 22.9* 25.5†	4,326	Aug. 31, 1893
28	Cambridge,	John L. Reardon & Co.,	6,503	4'×4' 6",	19.2* 23.0†	*6,424 †79	April 30, 1894

* Trench. † Tunnel. ‡ Part of.

TABLE OF SEWER WORK COMPLETED, ETC. — *Concluded.*

Section.	Locality.	Name of Contractor.	Total Length of Section. Feet.	Size of Sewer.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1894. Feet.	Date of Completion named in Contract.
29	Cambridge,	Lindsay & Cudmore,	5,157	4'×4' 6", 3' 8"×4' 2", 3' 6"×4',	16.2 12.9 18.0	5,157	Nov. 30, 1893
30	Cambridge,	Jones & Meehan,	7,032	3' 5"×3' 8", 2' 10"×3', 2' 8"×2' 10, 2' 3"×2' 4",	13.8 15.6 12.7	7,032	April 30, 1894
31	Charlestown,	Metropolitan Construction Co.,	4,500	2' 5"×3' 1", 3' 1"×3' 8", 2' 7"×3' 3", 1' 3",	27.4* 31.8† 23.7 –	1,650 –	Nov. 30, 1894
32	Charlestown,	Metropolitan Construction Co.,	4,702	2' 7"×3' 3", 2' 5"×3' 1", 2' 3"×3', 2' 1"×2' 10", 1' 7"×2' 4',	29.5 19.0 16.8 –	†606 *2,214 *23 –	Nov. 30, 1894
32	Charlestown Navy Yard,	Day work,	1,575	2' 1"×2' 10", 1' 10"×2' 7", 1' 7"×2' 4",	19.2* 16.8† –	*619 †41 –	–
35	Charlestown, Somerville and Medford,	James Heath & Son,	8,370	3' 4"×4' 1", 3' 3"×3' 11", 2' 11"×3' 7", 1' 10"×2' 3",	29.0* 28.0† – 21.5	*214 †1,680 – 1,286	Nov. 30, 1894
36	East Boston,	National Construction Co.,	237	1' 3" vitrified pipe,	18.5	237	Sept. 30, 1894
37	East Boston,	John Sheehan,	4,882	3' 4"×3' 9", 3'×3' 5",	30.0 26.5* 31.0†	*2,057 †2,738	June 30, 1894

37½	East Boston,	Day work,	276	3' 5"×3' 10 ,	28.0†	276	-
38	East Boston,	James Heath & Son,	8,229	3'×3' 5", 2', 1' 6", 1' 3", 1',	24 21 20 18	1,872	Nov. 15, 1894
39	East Boston,	Metropolitan Construction Co.,	6,963	1' 6", 1' 3," 1',	21 14.5	2,510	Oct. 30, 1894
40	Everett and Malden,	R. A. Malone & Sons,	6,252	3' 9"×4' 1",	16.0	6,252	Aug. 31, 1892
41	Malden and Melrose,	Moulton & O'Mahoney,	9,793	2' 1"×3' 2", 1' 10"×2' 9", 1' 8"×2' 6",	13.0	9,793	Sept. 29, 1893
41	Malden,	Day work,	1,014	2' 1"×3' 2", 1' 8"×2' 6",	10.0	1,014	-
42	Melrose and Stoneham,	David L. Clements,	3,050	1' pipe,	11.4	3,050	Nov. 30, 1892
43	Somerville and Cambridge,	Metropolitan Construction Co.,	14,450	2' 11"×3' 6", 2' 5'×3' 1", 2' 3"×2' 11", 1' 11"×2' 9", 1' 6" pipe, 1' 3" pipe,	20.0* 26.0† 10.5* 16.0† 7.0 7.0	14,450	Oct. 31, 1893
43½	Medford and Somerville,	Metropolitan Construction Co.,	2,312	3'×3' 7", 2' 11"×3' 6",	13.1	2,312	Aug. 31, 1893
43½	Siphon, Mystic River,	Day work,	150	6'×7' sand-catcher, 2' pipe siphon,	-	-	-
44	Winchester,	Jones & Meehan,	5,608	2' 7"×2' 11", 2' 3' ×2' 6", 2'×2' 5",	13.6* 20.0†	*5,354 †254	Nov. 30, 1893
44½	West Medford and Winchester,	Weaving, Booth & Co.,	5,605	2' 11"×3' 3", 2' 9"×3' 1",	12.0	5,605	Mar. 31, 1894
44½	Siphon, Abbajona River,	Abandoned contract work,	80	6'×14' sand-catcher, 1' 8" pipe siphon,	4.0	80	-
45	Winchester,	Everson & Liddle,	6,508	2'×2' 5", 1' 10"×2' 3",	9.6	6,508	Sept. 30, 1893
46	Winchester, Woburn and Stoneham,	Charles Linehan,	5,757	1' 10"×2' 3", 1' 6"×2', 1' 3" pipe,	10.0 8.7* 21.0†	5,757	Aug. 31, 1893
47	Winchester and Woburn,	Lindsey & Cudmore,	4,510	1' 8", 1' 6", 1' 3" pipe,	8.0	4,277	Aug. 31, 1894

* Trench. † Tunnel.

Where work on the same section has continued through two or more years some statistics and other statements contained in former reports have been repeated in succeeding ones for convenience of reference. This is desirable, among other reasons, on account of the great scarcity of former reports.

The foregoing detailed reports of sections are in general condensed from those of the various assistant engineers directly connected with the work.

Field Assistants.

Assistant Engineer William M. Brown, Jr., had general charge of the construction on sewers, except the outfall and those closely connected with siphons and pumping stations, until he left the work last February. During the spring, summer and early fall the construction of the Charlestown and Somerville branches was under the immediate direction of Assistant Engineer Edmund S. Davis, who also exercised a general supervision over the East Boston, Chelsea and Cummingsville branches. Other field assistants are mentioned in the preceding pages, where the work with which they were connected is more fully described.

During the early part of the year the work of construction was so far advanced that the services of many valuable assistants were no longer needed. All of these gentlemen soon found other situations. I desire again to express my high appreciation of the valuable work done by my former and present assistants.

Office Assistants.

Assistant Engineer: Charles H. Swan.
" Sidney Smith.*
" Winslow Blanchard.
" Frank M. Sherman.*
Assistant Engineer and Purchasing Clerk: Alfred F. Bridgman.
Draughtsman: Paul S. Yendell.*
" Alfred N. Wahlberg.
" Wm. J. Watkins.
" Henry Cleary.
" Frank A. Emery.
Clerk and Stenographer: Arthur B. Carter.
Assistant Stenographer: Wm. A. Nichols.*
Clerk: William Gray.
" Burton W. Torrey.
Plan Keeper: Alfred W. Trefry.*
" Harry L. Morrow.
Cement Tester: Nelson A. Hallett.
Photographer: Frank J. Nowell.*
" George P. Goodman.
Messenger: Madison C. Lewis.

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* For a portion of the year.

TIME OF COMPLETION.

An examination of the accompanying map shows that the important work of the system has nearly reached completion, and it is probable that before the spring of 1895 all of the northern system, with the exception of the Cambridge branch and small portions of other branches, will be ready for operation; and by that time the system, so far as Winthrop, Chelsea, Everett, Malden, Melrose, Medford, Winchester, Woburn and Stoneham are concerned, will be ready for use. The Cambridge branch proper lacks only the pumping station at Charlestown to make it complete. The foundations for the pumps and engines will be ready about January 1. If the contractor sets the engines up promptly, they should be ready to work at this place some time in May.

COST.

It is still very uncertain how the cost for land damages will compare with the amount originally estimated; but the testimony of capable and disinterested experts indicates that the amount so estimated will suffice.

Last winter an estimate was made which showed that the cost to complete the system would exceed the amount originally estimated by about ten per cent. The part then remaining to be done included difficult work of which the cost was extremely uncertain. According to the best estimate which can be made at the present time, from one and one-half to two per cent. additional will be needed to set the system in complete operation at every point, to do necessary grading, to put up necessary buildings, such as coal pockets, screen-houses, etc., to do other necessary work and to pay all legal claims.

In constructing this system numerous changes have been made from the original design that have resulted in increasing its capacity about ten per cent. Other changes have been made which are believed to have increased its usefulness and efficiency. These changes will, to a considerable extent, account for this increased cost of, say, twelve per cent. beyond the original estimate.

In closing this report — which may be the last that I shall make to your board — I desire to express my high appreciation of your constant consideration and kindness during the years that we have worked together.

Respectfully submitted,

HOWARD A. CARSON,
Chief Engineer.

APPENDIX.

TABLE A.

BIDS FOR CONSTRUCTION OF SECTIONS UPON NORTH METROPOLITAN SYSTEM.

NAMES OF BIDDERS.	RESIDENCE.	BIDS OPENED MAY 5, 1894.			
		SECTION 35.	SECTION 38.	SECTION 39.	SECTION 47.
		Charlestown, Somerville and Medford.	Boston.	East Boston.	Winchester and Woburn.
National Construction Company,	Boston,	$99,004 60	$47,811 80	$36,865 20	$11,998 90
Metropolitan Construction Company,	Boston,	97,864 20	39,498 10	27,046 50*	-
Jones & Meehan,	Jamaica Plain,	90,839 00	64,077 75	59,849 00	17,158 00
Lindsay & Cudmore,	Somerville,	89,500 00	-	-	7,390 00*
J. N. Drew & Co.,	Malden,	88,079 00	-	-	-
Weaving, Booth & Co.,	Dorchester,	84,182 50	-	-	-
C. McBride,	Brighton,	83,190 00	-	-	-
A. W. Bryne,	West Medford,	81,612 00	-	-	-
James Heath & Son,	Lynn,	73,182 50*	31,970 10*	-	-
Edw. F. Brigham,	West Medford,	-	39,676 65	27,926 20	-
Dennis O'Connell,	Dorchester,	-	38,272 00	-	11,421 50
Charles Linehan,	Cambridge,	-	-	-	9,612 70
Genaro, Long & Little,	Boston,	-	-	-	9,490 00
Ferguson Bros.,	South Boston,	-	-	-	9,355 90
L. A. Taylor,	Boston,	-	-	-	8,082 50
Fallon & Cronin,	Roxbury,	-	-	-	-
Thomas J. Young & Co.,	Boston,	-	-	-	-

* Contract awarded to.

TABLE A — *Concluded.*

NAMES OF BIDDERS.	RESIDENCE.	BIDS OPENED MAY 12, 1894.			BIDS OPENED AUG. 25, 1894.	BIDS OPENED DEC. 2, 1893.
		SECTION 11.	SECTION 31.	SECTION 32.	SECTION 36.	Abbajona River Siphon.
		Chelsea.	Charlestown.	Charlestown.	East Boston.	Winchester.
National Construction Company,	Boston,	$36,379 60	$47,987 00	$48,783 60	$932 80*	-
Metropolitan Construction Company,	Boston,	-	40,398 30*	40,776 10*	-	-
Jones & Meehan,	Jamaica Plain,	21,157 50	46,321 00	51,570 00	-	-
Lindsay & Cudmore,	Somerville,	-	41,687 50	-	-	$2,660 00
J N. Drew & Co.,	Malden,	24,953 50	-	-	-	-
Weaving, Booth & Co.,	Dorchester,	-	-	-	-	3,400 00
C. McBride,	Brighton,	-	-	-	-	-
A. W. Bryne,	West Medford,	-	-	-	-	-
James Heath & Son,	Lynn,	-	-	-	-	-
Edw. F. Brigham,	West Medford,	32,057 50	-	-	-	-
Dennis O'Connell,	Dorchester,	-	54,325 50	-	-	-
Charles Linehan,	Cambridge,	20,537 00*	-	-	-	-
Genaro, Long & Little,	Boston,	-	-	-	-	-
Ferguson Bros.,	South Boston,	-	-	-	-	-
L. A. Taylor,	Boston,	-	-	-	-	-
Fallon & Cronin,	Roxbury,	-	47,899 70	46,712 50	-	-
Thomas J. Young & Co.,	Boston,	-	-	-	-	2,297 00*

* Contract awarded to.

TABLE B.

BIDS FOR CONSTRUCTION OF PUMPING STATIONS UPON NORTH METROPOLITAN SYSTEM.

NAMES OF BIDDERS.	RESIDENCE.	BIDS OPENED MARCH 31, 1894.	BIDS OPENED APRIL 14, 1894.	BIDS OPENED AUG. 11, 1894.
		Deer Island.	East Boston.	Charlestown.
Andrew W. Bryne,	West Medford,	$33,915 00	-	-
Ivory F. Tarbox,	Malden,	31,889 00	-	-
Mack & Moore,	Boston,	30,200 00	$23,400 00	$19,000 00
George W. Bradford,	Plymouth,	29,991 00	-	-
Charles H. Dodge,	Boston,	29,615 00	-	-
George G. Baker,	Boston,	29,111 00	-	-
Connery & Wentworth,	Boston,	29,000 00	-	-
W. A. & H. A. Root,	Boston,	28,761 00	23,450 00	-
W. L. Clark & Co.,	Boston,	28,627 00	21,086 00	21,019 00
Mead, Mason & Co.,	Boston,	27,179 00	20,884 00	-
William L. Miller,	Boston,	25,873 00	21,500 00	-
John McDonald & Son,	Cambridge,	25,710 00	22,000 00	21,201 00
William A. Chapman & Co.,	Providence, R. I,	24,973 00	22,397 00	-
Whidden & Co.,	Boston,	24,499 00	-	-
Edward E. Strout,	Lynn,	24,370 00	19,400 00*	20,970 00
L. K. Marston,	Boston,	24,325 00	21,241 00	-
Gooch & Pray,	Boston,	23,450 00*	21,839 00	23,300 00
Isaac Weaver,	Boston,	-	22,067 00	-
Orne & Lawrence,	Boston,	-	25,500 00	-
Donahue Bros.,	Boston,	-	23,560 00	20,500 00
Eldredge & Sylvester,	Campbello,	-	22,000 00	-
Edward Lynch & Co.,	Boston,	-	-	17,549 00*
Woodbury & Leighton,	Boston,	-	-	17,900 00
Thomas Bros. & Co.,	Turner's Falls,	-	-	19,435 00
Kelly & McKinnon,	Boston,	-	-	19,600 00
Walter S. Sampson,	Boston,	-	-	19,784 00
Kerrans Driscoll,	Boston,	-	-	20,735 00
Norcross Bros.,	Boston,	-	-	23,952 00
Jones & Meehan,	Jamaica Plain,	-	-	24,175 00
William T. Eaton,	South Boston,	-	-	24,336 00
Henry Mellen & Son,	Worcester,	-	-	25,334 00

* Contract awarded to.

TABLE C.

NORTH METROPOLITAN SYSTEM.

SECTION.	Location.	Advertised for Bids.	Bids Opened.	Number of Bids.	Highest.	Lowest.	CONTRACT AWARDED TO —	Residence.	Amount Bid on Items for Comparison.	Work Began.	To be Completed.	Length of Section.
		1894.	1894.							1894.	1894.	Feet.
No. 35, . .	Charlestown, Somerville and Medford.	April 26,	May 5,	9	$99,004 60	$73,182 50	James Heath & Son, . .	Lynn, . .	$73,182 50	May 17,	Nov. 30,	8,350
No. 36, . .	East Boston, .	–	Aug. 25,	1	–	–	National Construction Co., .	Boston, .	932 80	Aug. 25,	Sept. 30,	230
No. 38, . .	East Boston, .	April 26,	May 5,	6	64,077 75	31,970 10	James Heath & Son, . .	Lynn, . .	31,970 10	May 21,	Nov. 15,	8,225
No. 39, . .	East Boston, .	April 26,	May 5,	4	59,849 00	27,046 50	Metropolitan Construction Co.,	Boston, .	27,046 50	May 14,	Oct. 30,	6,950
No. 47, . .	Winchester and Woburn.	April 26,	May 5,	8	17,158 00	7,390 00	Lindsay & Cudmore, . .	Somerville, .	7,390 00	May 17,	Aug. 31,	4,520
No. 11, . .	Chelsea, . .	May 6,	May 12,	5	36,379 60	20,537 00	Charles Linehan, . . .	Cambridge, .	20,537 00	May 22,	Sept. 30,	3,030
No. 31, . .	Charlestown, .	May 6,	May 12,	6	54,325 50	40,398 30	Metropolitan Construction Co.,	Boston, .	40,398 30	May 24,	Nov. 30,	4,500
No. 32, . .	Charlestown, .	May 6,	May 12,	4	51,570 00	40,776 10	Metropolitan Construction Co.,	Boston, .	40,776 10	May 21,	Nov. 30,	5,060
					$382,364 45	$241,300 50			$242,233 30			
		1894.	1894.							1894.	1894.	
Pumping Stat'n,	Deer Island, .	Mar. 13,	Mar. 31,	17	$33,915 00	$23,450 00	Gooch & Pray, . . .	Boston, .	$23,450 00	May 23,	June 30,	–
Pumping Stat'n,	East Boston, .	April 1,	April 14,	14	25,500 00	19,400 00	Edward E. Strout, . .	Lynn, . .	19,400 00	May 10,	July 15,	–
Pumping Stat'n,	Charlestown, .	July 25,	Aug. 11,	16	25,334 00	17,549 00	Edward Lynch & Co., . .	Boston, .	17,549 00	–	–	–
					$84,749 00	$60,399 00			$60,399 00			
					$467,113 45	$301,699 50			$302,632 30			

Table D.

MAINTAINING AND OPERATING CHARLES RIVER VALLEY SEWER.

1893.	Dr.			
Oct. 1,	To balance unexpended from appropriation of 1893,	. .	. .	$13,350 56
1894.				
Feb. 3,	To appropriation made by chapter 6, Acts of 1894,	. .	. .	27,000 00
1893.	Cr.			$40,350 56
Oct. 31,	By amount paid for travelling expenses, . . .	$15 25		
31,	" " for supplies, ...	62 56		
31,	" " for labor, ...	144 00		
31,	" " for inspector's salary, . . .	130 00		
31,	" " city of Boston, disposing of sewage to date, ...	5,750 00	$6,101 81	
Nov. 30,	By amount paid for travelling expenses, . . .	$9 05		
30,	" " for supplies, ...	36 02		
30,	" " for labor, ...	184 30		
30,	" " for inspector's salary, . . .	130 00	359 37	
Dec. 30,	By amount paid for travelling expenses, . . .	$10 80		
30,	" " for supplies, ...	63 97		
30,	" " for labor, ...	144 00		
30,	" " for inspector's salary, . . .	130 00		
30,	" " city of Boston, disposing of sewage to date, ...	5,750 00	6,098 77	
1894.				
Jan. 31,	By amount paid for travelling expenses, . . .	$4 35		
31,	" " for supplies, ...	43 98		
31,	" " for labor, ...	249 30		
31,	" " for inspector's salary, . . .	130 00	427 63	
Feb. 28,	By amount paid for travelling expenses, . . .	$4 95		
28,	" " for supplies, ...	121 87		
28,	" " for labor, ...	144 00		
28,	" " for inspector's salary, . . .	135 00	405 82	
Mar. 31,	By amount paid for travelling expenses, . . .	$16 95		
31,	" " for supplies, ...	169 05		
31,	" " for labor, ...	185 62		
31,	" " for inspector's salary, . . .	120 00		
31,	" " city of Boston, disposing of sewage to date, ...	5,750 00	6,241 62	
Apr. 30,	By amount paid for travelling expenses, . . .	$4 85		
30,	" " for supplies, ...	58 54		
30,	" " for labor, ...	179 33		
30,	" " for inspector's salary, . . .	135 00	377 72	
May 31,	By amount paid for travelling expenses, . . .	$7 20		
31,	" " for supplies, ...	18 19		
31,	" " for labor, ...	55 53		
31,	" " for inspector's salary, . . .	50 00	130 92	
June 30,	By amount paid for travelling expenses, . . .	$7 70		
30,	" " for supplies, ...	15 92		
30,	" " for labor, ...	68 62		
30,	" " for inspector's salary, . . .	70 00		
30,	" " city of Boston, disposing of sewage to date, ...	5,750 00	5,912 24	
July 31,	By amount paid for travelling expenses, . . .	$7 26		
31,	" " for supplies, ...	31 61		
31,	" " for labor, ...	51 23		
31,	" " for inspector's salary, . . .	45 00	135 10	
Aug. 31,	By amount paid for travelling expenses, . . .	$5 51		
31,	" " for supplies, ...	20 31		
31,	" " for labor, ...	36 96		
31,	" " for inspector's salary, . . .	50 00	112 78	
Sept. 29,	By amount paid for travelling expenses, . . .	$7 82		
29,	" " for supplies, ...	8 68		
29,	" " for labor, ...	28 17		
29,	" " inspector's salary, ...	40 00	84 67	
				26,388 45
	Balance, ...	. .	. .	$13,962 11

EXPENDITURES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS TO SEPT. 30, 1894.

	Year ending Sept. 30, 1889.	Year ending Sept. 30, 1890.	Year ending Sept. 30, 1891.	Year ending Sept. 30, 1892.	Year ending Sept. 30, 1893.	Year ending Sept. 30, 1894.	Total.
Office expenses, ...	$1,161 29	$28,792 85	$30,437 29	$31,220 76	$35,191 97	$33,669 39	$160,473 55
North Metropolitan system, .	–	116,492 55	582,966 06	962,798 49	1,172,269 02	1,115,190 19	3,949,716 31
Charles River system, . .	–	18,329 41	381,149 33	280,308 29	28,882 27	25,369 13	734,038 43
Both systems, ...	–	2,696 20	5,597 86	7,703 15	12,783 61	15,864 20	44,645 02
	$1,161 29	$166,311 01	$1,000,150 54	$1,282,030 69	$1,249,126 87	$1,190,092 91	$4,888,873 31

Total amount expended to Sept. 30, 1894, $4,888,873.31.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1894.

Office Expenses.

	1893.			1894.									Total.
	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	
Salaries, — Commissioners,	$750 00	$750 00	$750 00	$750 00	$750 00	$750 00	$750 00	$750 00	$750 00	$750 00	$750 00	$750 00	$9,000 00
Clerk and chief engineer,	833 33	833 33	833 34	833 33	833 33	833 34	833 33	833 33	833 34	833 33	833 33	833 34	10,000 00
Clerical services,	381 66	381 66	381 67	381 66	381 67	381 67	381 66	381 66	381 67	381 66	381 66	381 67	4,579 97
Cement testing,	149 68	124 84	174 52	174 52	100 00	100 00	100 00	100 00	100 00	100 00	100 00	100 00	1,423 56
Office rent,	254 17	254 17	254 17	254 17	254 17	254 17	254 17	508 34	254 17	254 17	254 17	254 17	3,304 21
Care of office,	26 00	26 00	26 00	26 00	-	52 00	26 00	26 00	52 00	-	26 00	26 00	312 00
Travelling expenses,	-	49 04	28 44	119 49	25 96	19 34	14 20	27 72	97 60	26 66	-	3 99	412 44
Postage, telegrams and express,	1 59	1 55	13 32	7 49	51 00	11 10	34 55	61 69	21	14 79	45 00	25 18	267 47
Supplies,	75 32	209 60	418 10	294 40	152 31	182 90	374 78	418 98	253 02	396 84	158 45	316 19	3,250 89
Books and atlases,	-	-	25 00	-	-	-	-	-	-	-	-	-	25 00
Blue printing,	-	39 48	74 50	64 36	27 10	53 56	10 80	31 44	-	53 70	-	37 07	392 01
Photography,	70 43	1 25	69 08	13 38	17 65	14 84	-	3 75	10 25	73 59	45 79	88 75	408 76
Engineers' instruments,	-	-	-	-	-	-	-	66 67	110 87	74 20	1 20	40 14	293 08
Totals,	$2,542 18	$2,670 92	$3,048 14	$2,918 80	$2,593 19	$2,652 92	$2,779 49	$3,209 58	$2,843 13	$2,958 94	$2,595 60	$2,856 50	$33,669 39

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1894.

North Metropolitan System.

	1893.			1894.									Totals.
	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	
Salaries, — engineers, inspectors and all others, including labor,	$10,561 87	$13,188 08	$6,206 39	$4,117 32	$1,492 76	$5,969 19	$350 96	$5,207 58	$3,685 25	$4,363 33	$4,751 06	$6,568 75	$66,462 54
Travelling expenses,	336 35	591 85	153 54	90 01	81 11	211 88	196 60	99 03	114 48	122 32	158 42	145 51	2,301 10
Postage, telegrams and express,	129 17	252 56	57 03	1 15	45 40	9 00	14 90	35 92	9 00	72 72	1 97	7 44	636 26
Moulds, patterns and castings,	20 20	-	-	-	-	-	-	-	-	-	-	-	20 20
Man-hole covers, etc.,	1,867 74	342 80	26 08	30 06	66 29	-	-	97 11	177 60	399 62	-	230 92	3,238 22
Land taking, purchase and recording,	621 75	13,972 03	709 05	3,122 00	1,911 65	1,039 69	1,726 51	983 35	1,578 50	2,620 25	203 10	2,016 71	30,504 59
Maps, plans and blue prints,	-	11 77	-	3 00	17 25	8 13	-	87 44	45 12	-	24 31	13 00	210 02
Experts and appraisers,	440 83	394 65	449 85	765 00	271 87	44 99	143 85	24 00	-	10 00	10 00	-	2,555 04
Tools and repairs of same,	502 78	107 97	-	5 70	35	3 65	-	-	-	-	-	-	620 45
Boat and boat hire,	-	59 25	-	-	-	-	-	-	-	-	-	-	59 25
Changing water pipes,	-	16 63	-	-	-	-	-	6 87	-	-	95 00	-	118 50
Medical and legal services,	125 00	710 00	65 20	351 00	1,200 00	-	-	-	116 04	-	20 00	-	2,587 24
Cement and gravel,	1,612 82	2,139 70	1,319 97	193 89	418 17	656 83	1,155 26	124 13	945 85	233 88	44 65	92 30	8,937 45
Advertising for proposals,	-	-	-	-	4 25	-	38 38	127 26	38 90	-	-	-	208 79
Lumber and field supplies,	62 44	118 00	1,161 09	477 75	244 10	280 81	167 50	348 91	1,295 39	674 96	686 03	1,080 81	6,597 79
Brick,	152 25	517 45	-	137 25	-	110 25	-	-	-	-	-	-	917 20

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR YEAR ENDING SEPT. 30, 1894 — *Continued.*

North Metropolitan System — Continued.

	1893.			1894.									Totals.
	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	
Payments on account of contracts.													
*Sect. 1 — Deer Island,	$12,695 61	$11,021 65	$4,701 12	$2,243 86	$1,540 08	$106 98	$188 71	$126 50	$1,956 18	$7,724 31	$7,639 74	$24,727 04	$74,671 78
*Sect. 3½ — Shirley Gut,	6,668 05	8,580 22	1,651 13	592 66	1,892 79	2,906 67	3,890 22	2,473 78	6,199 79	3,686 69	608 46	38 21	39,188 67
Trumbull & Ryan, —													
*Sect. 7 — East Boston and Winthrop, .	2,602 91	2,644 41	-	3,020 40	2,716 13	-	3,000 00	2,350 00	4,033 52	306 00	872 13	3,989 66	25,535 16
*Sect. 10 — Chelsea Creek, . . .	7,922 81	2,379 66	5,403 38	5,144 54	3,633 71	5,107 62	3,877 77	4,774 43	2,013 71	2,149 12	1,686 51	193 40	44,286 66
Charles Linehan, —													
Sect. 11 — Chelsea, .	-	-	-	14 83	89 52	288 87	37 80	76 20	-	2,169 24	3,179 25	3,583 36	9,439 07
Sect. 46 — Winchester, Woburn and Stoneham, ...	2,729 43	1,040 56	-	-	1,827 45	-	-	906 67	-	-	-	-	6,504 11
Orrin P. Roberts, —													
Sect. 12 — Chelsea, .	-	3,777 73	-	-	-	-	-	-	4,300 00	-	-	-	8,077 73
*Sect. 12 — Chelsea Creek, . . .	2,429 43	70 61	69 48	-	43 45	-	-	-	-	-	23 70	22 90	2,659 57
Metropolitan Construction Co., —													
Sect. 14 — Chelsea, .	660 78	-	-	-	-	-	-	-	-	21,800 00	-	-	22,460 78
Part of Sect. 27 — Somerville and Cambridge, . . .	2,750 49	2,258 13	1,070 10	1,665 09	226 49	-	-	-	779 93	-	-	-	8,750 23
Sect. 31—Charlestown,	-	-	-		-	-	-	-	-	2,439 40	8,691 28	4,978 55	16,109 23
Sect. 32—Charlestown,	-	-	-	-	-	-	-	-	6,953 74	5,980 78	3,367 38	4,953 68	21,255 58
Sect. 39—East Boston,	-	-	-	-	-	-	-	-	-	1,338 47	2,418 58	3,401 29	7,158 34

Sect. 43 — Somerville and Cambridge, .	11,247 06	8,939 25	7,557 75	5,645 00	-	-	-	3,000 00	-	1,322 48	-	-	37,711 54
Sect. 43½ — Medford and Somerville, .	704 63	-	-	667 09	-	-	-	1,083 53	-	-	-	-	2,455 25
Christy McBride, —													
Sect. 15 — Chelsea, .	-	2,729 19	-	-	-	-	-	-	-	-	-	-	2,729 19
Sect. 17 — Everett, .	-	-	-	2,910 23	-	-	-	-	-	-	-	-	2,910 23
R. A. Malone & Son, —													
Sect. 16 — Everett, .	-	-	3,602 58	-	-	-	-	-	-	-	-	-	3,602 58
Sect. 23 — Everett, .	-	-	1,054 47	-	-	-	-	-	-	-	-	-	1,054 47
Sect. 40 — Everett and Malden, ...	-	-	5,812 44	-	-	-	-	-	-	-	-	-	5,812 44
*Sect. 19 — Malden Riv.,	-	-	-	72 86	34 08	63 91	276 94	646 51	7,128 22	6,328 56	5,531 11	4,276 31	24,358 50
John Sheehan, —													
Sect. 20 — Medford, .	-	-	-	-	3,915 97	-	-	-	-	-	-	-	3,915 97
Sect. 37 — E. Boston, .	4,137 05	4,053 22	3,200 24	3,973 61	3,224 37	2,074 15	4,295 63	3,611 77	5,547 27	4,507 93	-	-	38,625 24
Andrew W. Byrne, —													
Sect. 22 — Medford, .	7,430 23	4,910 17	2,514 79	-	8,903 21	-	-	-	4,897 51	-	-	-	28,655 91
*Sect. 25 — Lower Mystic River siphon, .	9,882 75	5,419 46	6,518 67	6,377 16	4,208 51	6,348 20	2,657 83	2,499 59	2,320 23	1,168 63	2,182 07	2,279 56	51,862 66
*Sect. 25½ — Tufts' Mill Pond, . . .	-	4,038 96	3,740 45	2,979 30	3,706 74	4,609 43	2,434 52	2,848 79	81 96	47 83	12 40	-	24,500 38
H. P. Nawn, —													
Sect. 26 — Charlestown and Somerville, .	-	3,864 96	-	-	-	-	-	-	-	-	-	-	3,864 96
McGovern & Kitch, —													
Sect. 27 — Somerville and Cambridge, .	1 27	-	-	-	-	-	42 00	-	-	-	-	-	43 27
John L. Reardon & Co., —													
Sect. 28 — Cambridge,	8,062 40	3,000 00	7,432 42	788 06	-	1,826 58	-	106 52	-	-	4,137 93	-	25,353 91
Lindsey & Cudmore, —													
Sect. 29 — Cambridge,	4,833 73	9,394 03	3,531 69	3,620 91	-	1,826 58	1,557 68	-	-	-	-	2,739 84	27,504 46
Sect. 47 — Winchester and Woburn, . .	-	-	-	-	-	-	-	-	2,743 72	1,693 38	-	-	4,437 10

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* Work done by day labor. † This section was taken from the contractors July 21, 1894, to be completed by the Board at contractors' expense. (See report, page 27.)

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR YEAR ENDING SEPT. 30, 1894 — *Concluded.*

North Metropolitan System — Concluded.

	1893.			1894.									Totals.
	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	
Jones & Meehan, —													
Sect. 30 — Cambridge,	$16,644 04	$10,494 50	$601 67	$1,601 34	-	-	-	-	$3,000 00	-	-	-	$32,341 55
Sect. 44 — Winchester,	4,619 83	6,407 31	9,277 98	1,934 03	$2,816 21	-	-	-	-	$1,992 47	-	-	27,047 83
*Sect. 32 — Charlestown Navy Yard, . .	-	-	-	-	-	-	-	-	-	371 10	$4,701 62	$3,854 00	8,926 72
James Heath & Son, —													
Sect. 35 — Charlestown, Somerville and Medford, ...	-	-	-	-	-	-	-	-	-	4,754 62	6,445 06	9,959 41	21,159 09
Sect. 38 — E. Boston, .	-	-	-	-	-	-	-	-	3,215 52	4,505 17	3,536 27	2,984 07	14,241 03
*Sect. 37½ — Chelsea Creek, . . .	-	-	-	-	-	-	-	$247 66	912 44	944 68	852 95	458 60	3,416 33
*Sect. 39 — E. Boston, .	-	-	-	-	-	-	-	-	-	-	-	105 91	105 91
Moulton & O'Mahoney, —													
Sect. 41 — Malden and Melrose, . . .	-	3,026 81	208 26	6,465 17	-	-	-	-	3,032 59	-	200 00	-	12,932 83
David L. Clements, —													
Sect. 42 — Melrose and Stoneham, . .	-	-	-	-	300 00	$238 92	-	-	-	-	-	-	538 92
Weaving, Booth & Co., —													
Sect. 44½ — Winchester,	6,728 41	8,075 78	5,739 14	2,743 74	-	3,425 09	-	1,000 00	-	712 55	-	-	28,424 71
Everson & Liddle, —													
Sect. 45 — Winchester,	3,211 84	-	2,847 54	-	-	-	$1,421 52	-	-	-	-	-	7,480 90
*Upper Mystic River siphon, . . .	-	-	-	-	-	-	-	-	-	2 25	-	144 94	147 19

Abbajona River siphon:													
Thos. J. Young & Co.,	-	-	-	-	667 52	300 00	-	-	-	-	-	-	967 52
*State work, . .	-	-	-	-	-	-	-	-	-	-	1,155 75	1,359 14	2,514 89
*East Boston Pumping Station, . . .	-	207 28	2,736 43	8,943 34	2,394 98	9,027 17	9,719 20	9,003 01	11,034 99	7,427 98	3,215 33	3,359 93	67,069 64
*Deer Island Pumping Station, . . .	-	727 85	5,360 27	5,670 93	4,519 66	7,206 59	7,260 40	4,671 19	3,590 84	847 11	521 46	1,352 24	41,728 54
*Charlestown Pumping Station, . . .	-	-	-	70 88	495 16	4,748 90	7,838 45	13,383 74	19,012 34	9,779 15	7,544 04	15,015 93	77,888 59
Deer Island:													
Edw'd P. Allis Co., — Pumps, . . .	-	-	-	-	4,162 32	-	5,415 53	-	2,366 07	-	9,037 98	-	20,981 90
Gooch & Pray, — Pumping Station, .	-	-	-	-	-	-	-	-	7,820 00	-	2,380 00	-	10,200 00
East Boston:													
Edw'd P. Allis Co., — Pumps, . . .	-	-	-	-	5,021 53	-	5,698 59	-	2,181 28	-	-	-	12,901 40
Edward E. Strout, — Pumping Station, .	-	-	-	-	-	-	-	-	5,525 00	-	6,566 25	3,293 75	15,385 00
Charlestown:													
Edw'd P. Allis Co., — Pumps, . . .	-	-	-	-	2,502 19	-	2,497 84	-	2,320 06	-	-	-	7,320 09
Grand totals, . .	$132,395 95	$139,484 48	$94,780 20	$76,439 16	$64,595 27	$58,440 08	$65,904 59	$59,951 49	$120,973 04	$102,496 98	$92,501 79	$107,227 16	$1,115,190 19

* Work done by day labor.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR YEAR ENDING SEPT. 30, 1894.

Charles River System.

	1893.			1894.									Totals.
	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	
Salaries—Attorney,	$25 00	$25 00	$25 00	$25 00	$25 00	$25 00	$25 00	$25 00	$25 00	$25 00	$25 00	$25 00	$300 00
Supplies,	76 35	80	-	14 40	-	10 00	-	1 88	7 33	-	-	-	110 76
Land taking, purchase and recording,	300 00	550 00	707 75	300 00	-	827 76	-	40 29	2,672 21	6,348 81	-	7,438 10	19,184 92
Travelling expenses,	14 75	7 15	-	-	3 35	-	-	4 50	-	-	-	-	29 75
Man-hole covers, etc.,	60 47	-	-	3 66	-	-	-	-	-	-	-	-	64 13
Experts and appraisers,	-	235 44	700 00	154 70	-	10 00	192 00	300 00	331 43	-	406 00	-	2,329 57
Legal services,	-	1,200 00	1,700 00	-	-	-	-	-	450 00	-	-	-	3,350 00
	$476 57	$2,018 39	$3,132 75	$497 76	$28 35	$872 76	$217 00	$371 67	$3,485 97	$6,373 81	$431 00	$7,463 10	$25,369 13

Both Systems.

	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Totals.
Engineers, inspectors and labor,	$1,428 58	$2,748 43	$1,586 84	$1,668 63	$170 31	$2,659 99	$1,203 75	$1,144 99	$1,046 83	$1,107 51	$1,046 34	$52 00	$15,864 20

ASSETS AND LIABILITIES SEPT. 30, 1894.

ASSETS.

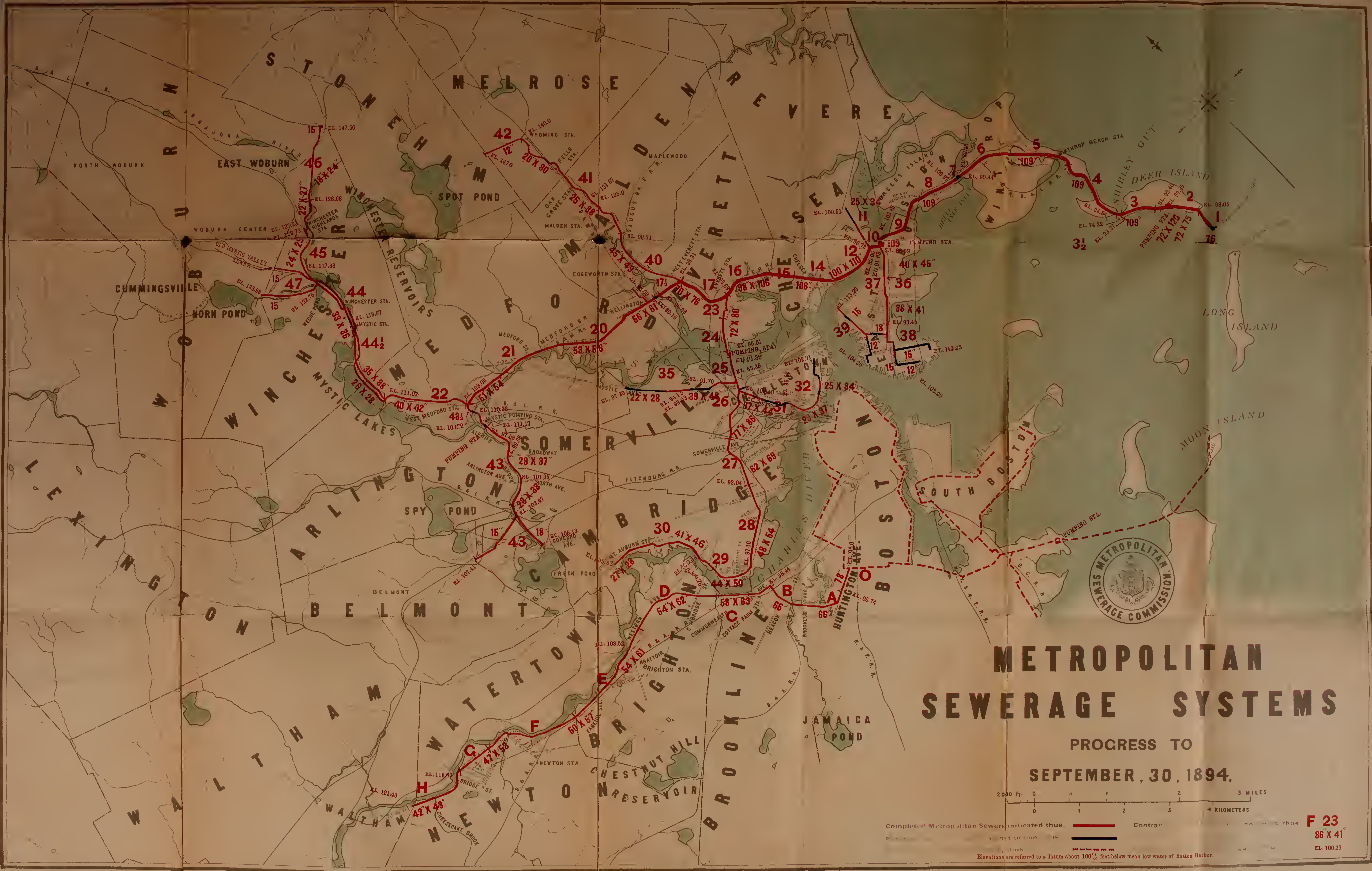
Office furniture, fittings and supplies, including fittings for field offices, stationery and railroad tickets,		$2,826 62
Engineering instruments and supplies,		3,912 86
Engines, pumps, boilers, derricks, inclines and heavy appliances,		15,340 85
Miscellaneous tools,		3,902 09
Miscellaneous supplies, including lumber, bricks, cement, etc.,		11,597 53
Engineers' field offices, sheds, tool houses, etc.,		3,395 00
Stock yard and building, East Boston,		2,500 00
House and lot, Pearl Street, Chelsea,		3,500 00
Vacant lots, Winthrop,		1,800 00
Cash received as follows: —		
Balance Sept. 30, 1893,	$1,002 64	
For sale of scow, pile buts, etc.,	107 25	
For rent of house, 63 Pearl Street, Chelsea,	144 00	
		1,253 89
		$50,028 84

There are numerous necessary plans, drawings, calculations and studies relating to the work to which no stated value can be assigned; also about forty-five miles of completed sewer.

LIABILITIES.

Salaries due engineers, inspectors, rodmen, laborers and others,	$3,789 80
Due for labor for maintaining Charles River Valley System,	8 79
Amounts due contractors,	16,785 67
Amounts due sundry parties for cement and brick,	7,862 35
Sundry small bills,	25,472 47
	$53,919 08

There are also various amounts due contractors upon several sections of the work which will be paid on succeeding estimates or after the completion of their contracts.

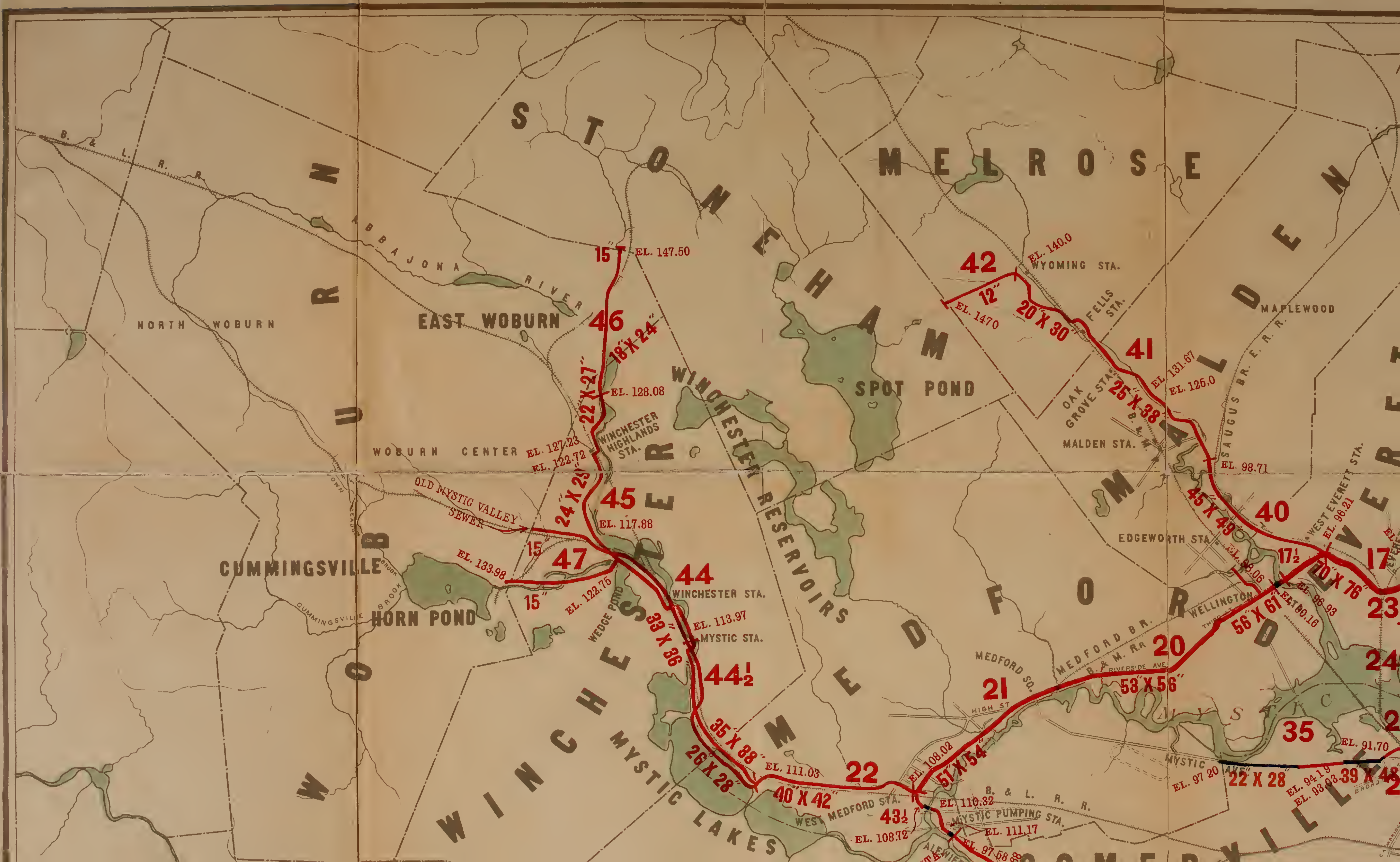


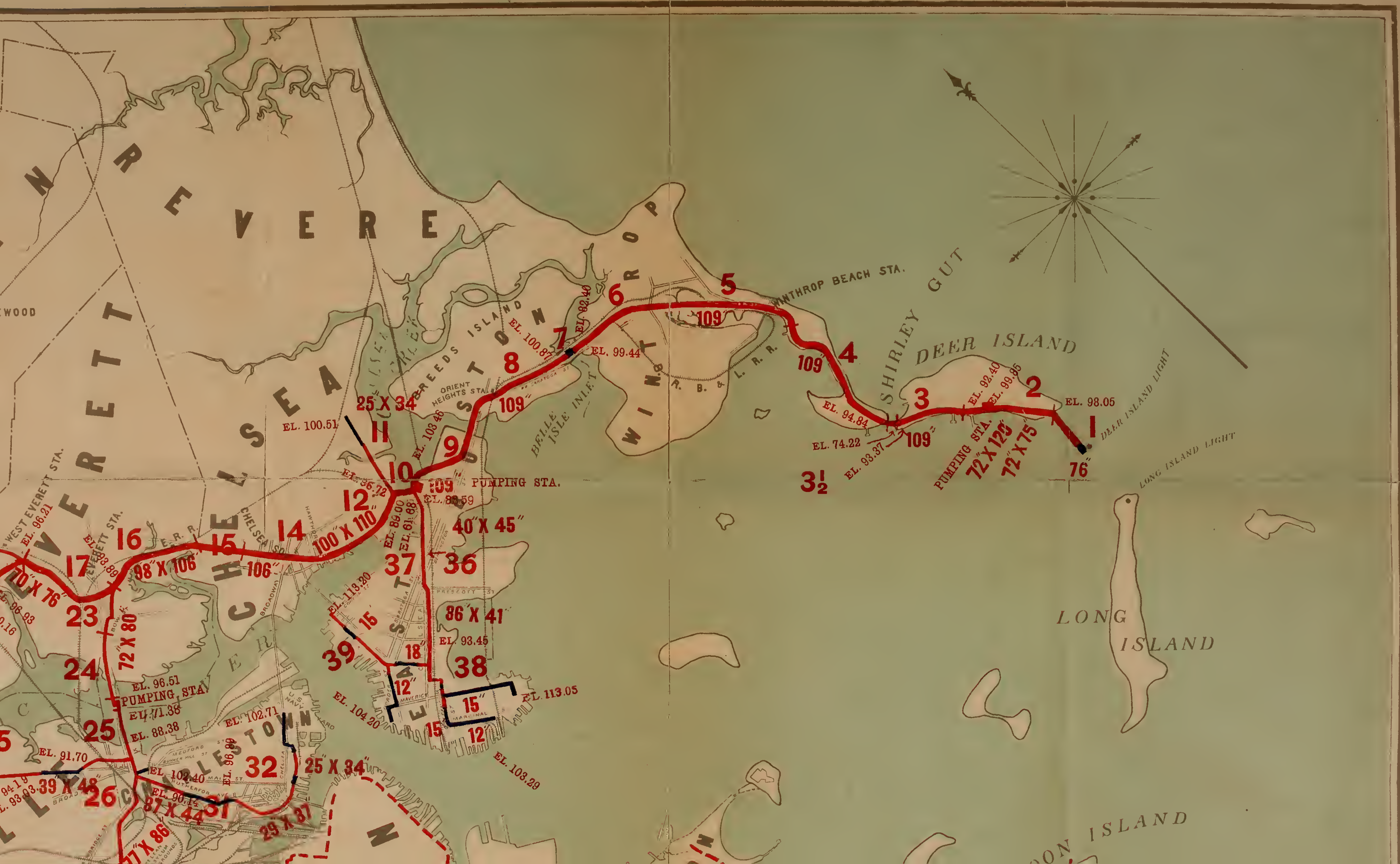
METROPOLITAN SEWERAGE SYSTEMS

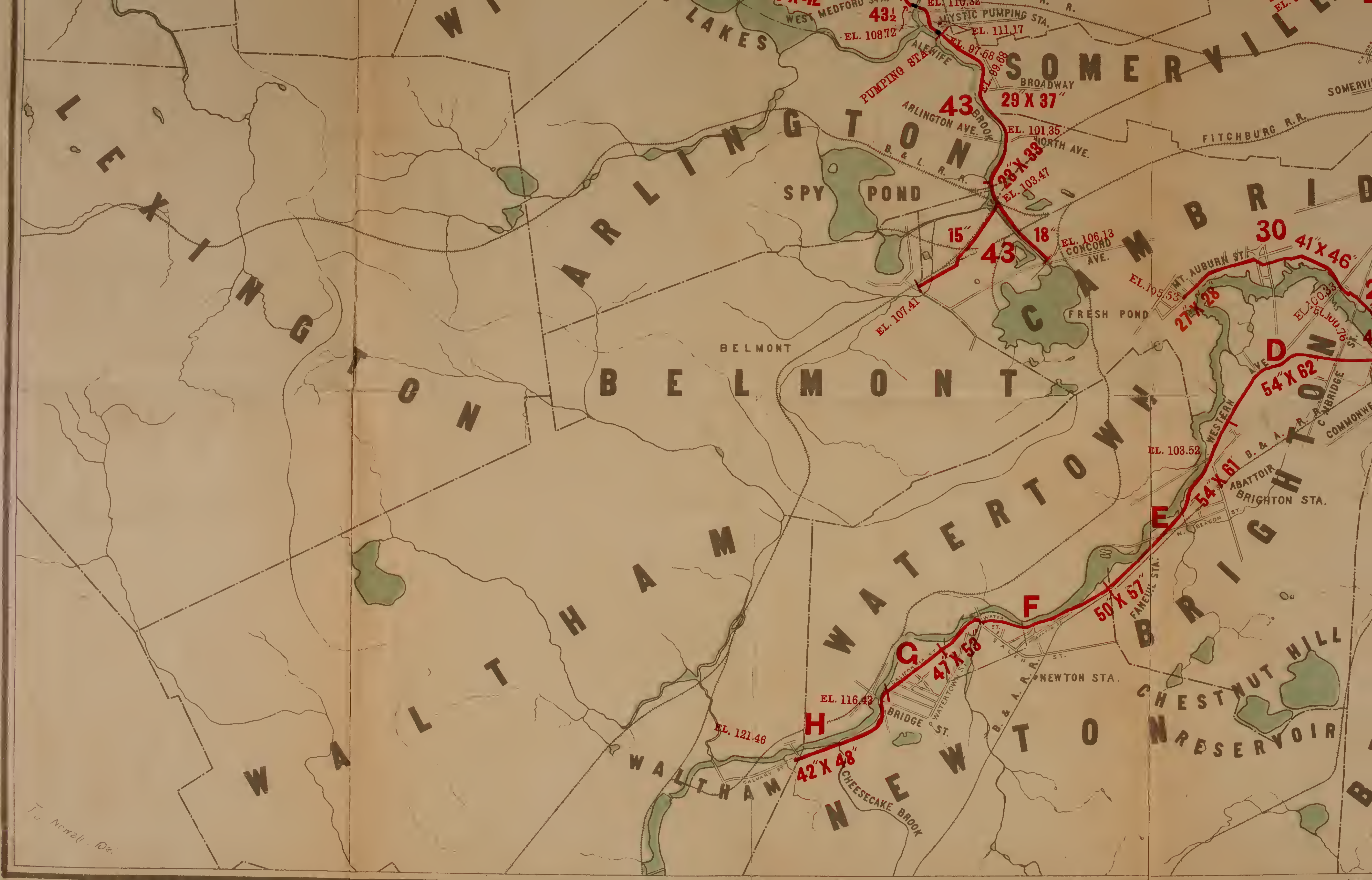
PROGRESS TO

SEPTEMBER, 30, 1894.

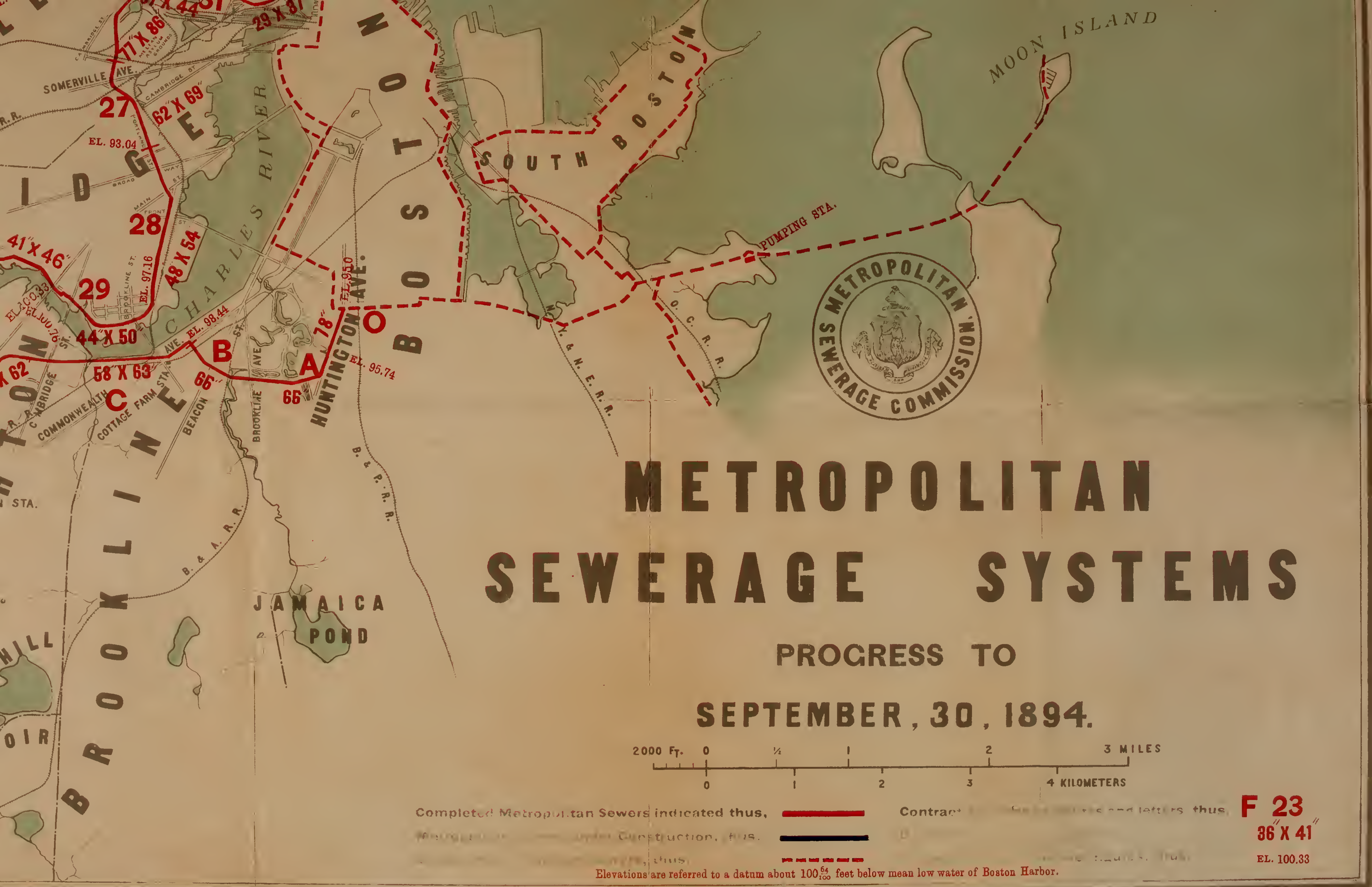
Elevations are referred to a datum about $100\frac{64}{100}$ feet below mean low water of Boston Harbor.


WOBURN
STONEHAM
MELROSE
MALDEN
EVERET
MEDFORD
WINCHESTER
OMERVILL
B. & L. R. R.
ABBAJONA RIVER
NORTH WOBURN
EAST WOBURN
WOBURN CENTER
CUMMINGSVILLE
CUMMINGSVILLE BROOK
HORN POND
HORN POND BROOK
WEDGE POND
SPOT POND
WINCHESTER RESERVOIRS
MYSTIC LAKES
OLD MYSTIC VALLEY SEWER
15" EL. 147.50
46
18"X 24"
22"X 27"
EL. 128.08
WINCHESTER HIGHLANDS STA.
EL. 127.23
EL. 122.72
24"X 29"
45
EL. 117.88
15"
47
EL. 133.98
15"
EL. 122.75
44
WINCHESTER STA.
33"X 36"
EL. 113.97
MYSTIC STA.
44½
35"X 38"
26"X 28"
EL. 111.03
22
40"X 42"
WEST MEDFORD STA.
43½
EL. 108.72
EL. 108.02
51"X 54"
EL. 110.32
MYSTIC PUMPING STA.
EL. 111.17
EL. 97.58
ALEWIFE
42
EL. 140.0
WYOMING STA.
12"
EL. 1470
20"X 30"
FELLS STA.
41
OAK GROVE STA.
25"X 38"
B. & M.
EL. 131.67
EL. 125.0
MALDEN STA.
MAPLEWOOD
SAUGUS BR. E. R. R.
EL. 98.71
45"X 49"
40
EDGEWORTH STA.
EL. 98.06
17½
WEST EVERETT STA.
EL. 96.21
17
70"X 76"
EL. 96.93
EL. 100.16
56"X 61"
WELLINGTON
THIRD ST
23
24
MEDFORD BR. B. & M. R.R.
RIVERSIDE AVE.
20
53"X 56"
MEDFORD SQ.
21
HIGH ST
MYSTIC
35
EL. 91.70
MYSTIC AVE.
EL. 97 20
22"X 28"
EL. 94.19
EL. 93.03
39"X 48"
BROAD
B. & L. R. R.


REVERE
EVERETT
CHELSEA
WINTHROP
DEER ISLAND
SHIRLEY GUT
WINTHROP BEACH STA.
DEER ISLAND LIGHT
LONG ISLAND LIGHT
LONG ISLAND
ISLAND
BELLE ISLE INLET
BREEDS ISLAND
ORIENT HEIGHTS STA.
PUMPING STA.
EAST BOSTON
CHARLESTOWN
WEST EVERETT STA.
EVERETT STA.
EWOOD
1
2
3
3½
4
5
6
7
8
9
10
11
12
14
15
16
17
23
24
25
26
31
32
36
37
38
39
76"
109"
109
72" X 120"
72" X 75"
25 X 34
100" X 110"
98" X 106"
106"
70" X 76"
72" X 80"
40" X 45"
86" X 41"
39 X 48
87 X 44
29 X 37
25 X 34"
15"
18"
12"
EL. 98.05
EL. 99.85
EL. 92.40
EL. 94.84
EL. 74.22
EL. 93.37
EL. 99.44
EL. 83.40
EL. 100.87
EL. 100.51
EL. 103.46
EL. 96.72
EL. 88.59
EL. 89.00
EL. 61.88
EL. 96.21
EL. 93.89
EL. 113.20
EL. 93.45
EL. 113.05
EL. 104.20
EL. 103.29
EL. 96.51
EL. 71.38
EL. 88.38
EL. 102.71
EL. 96.89
EL. 91.70
EL. 102.40
EL. 90.14
EL. 94.19
EL. 93.03
B. R. B. & L. R. R.
E. R. R.
MAVERICK
MARGINAL
PRESCOTT ST
BROADWAY
CHELSEA ST
MAIN ST
RUTHERFORD AVE



WRIGHT & POTTER PTG CO BOSTON.   Geo. H. Walker & Co. Lith. Boston.



METROPOLITAN SEWERAGE SYSTEMS

PROGRESS TO

SEPTEMBER, 30, 1894.

Completed Metropolitan Sewers indicated thus, 🟥

[illegible] under Construction, thus, ▬

[illegible], thus, - - - -

Contract [illegible] letters, thus, F 23

[illegible] 36″ X 41″

[illegible] figures, thus, EL. 100.33

Elevations are referred to a datum about $100\frac{64}{100}$ feet below mean low water of Boston Harbor.